TRANSACTIONS

OF

THE LINNEAN SOCIETY.

I. *On the Structure and Affinities of* Balanophoreæ. *By* Joseph Dalton Hooker, *Esq., M.D., F.R.S., F.L.S., &c.*

Read February 6th, February 20th and June 19th, 1855.

THE materials from which this Essay has been drawn up, have been accumulating on my hands for a considerable period. They consist principally of—1. A very complete set of the American species, especially of the *Helosideæ*, formed at the desire of Sir William Hooker, in New Grenada, Jamaica, and Trinidad, in 1846 and 1847, by Mr. William Purdie, at that time collector for the Royal Gardens at Kew. He gathered nine species, including several new genera, and preserved many specimens of most, both dried and in spirits. 2. I am indebted to Prof. Liebmann of Copenhagen for the species collected by him in Mexico, together with drawings of them; a translation of his paper on *Thonningia* and *Helosis mexicana*, read before the Society of Scandinavian Naturalists at Christiania; and the loan of the original specimens of *Thonningia*, from the herbaria of Vahl and Schumacher. 3. Mr. Miers has placed at my disposal his Brazilian specimens of *Langsdorffia hypogæa* and *Helosis guyanensis*, from Rio and the La Plata district, together with his sketches of them made on the spot. 4. Sir Robert Schomburgk has given me his drawings of the same genera, made in Guiana; and I have also received from other travellers numerous specimens of them. 5. For the South African genera *Sarcophyte* and *Mystropetalon* I am indebted to Dr. Harvey, who, during his residence at the Cape, communicated beautiful specimens of them to Sir William Hooker. 6. Of the Indian *Balanophoreæ* I have very extensive suites of specimens indeed; having had, in the Himalaya and Khasia mountains, the opportunity of studying several species in many stages of growth. I have also examined most of the specimens collected by Mr. Griffith himself, from which he described the species for the Society's Transactions; and I have received the Peninsular and Ceylon *B. indica* from Wight, Gardner, and Thwaites. 7. Sir William Hooker has procured the Javanese species from Mr. Thomas Lobb, Prof. de Vriese of Leyden, and others. 8. For specimens of the original species of *Balanophora* (*B. fungosa* of Forster), I am indebted to Mr. M'Gillivray, who found it on the N.E. coast of

Australia, during the voyage of H.M.S. "Rattlesnake;" and I have also received it from Tanna (the place of its original discovery by Forster), where it was collected by Mr. Hinds, during the visit of H.M.S. "Sulphur" to that island:—these I have compared with Forster's original specimens in the British Museum. 9. For other species I have been indebted to various sources, including the herbarium of the British Museum, which contains the original specimen of *Lophophytum mirabile**.

The total number of species thus brought together is about twenty-eight, of which I have examined both sexes of twenty-six.

I have not considered it necessary to give a detailed list of the authorities who have written upon this Order, nor a history of the successive additions that have been made to our knowledge of it; these subjects having been minutely and well detailed by Richard, Griffith, and Endlicher; and a *résumé* of them by Dr. Lindley will be found in his valuable 'Vegetable Kingdom.' I may however mention that, in their several ways, the original Essay of the great Linnæus upon *Cynomorium*, in the fourth volume of the 'Amœnitates Academicæ,'—the admirable one of Richard on *Cynomorium*, *Helosis*, and *Langsdorffia*, in the 'Mémoires du Muséum,'—Gœppert's very valuable remarks on the anatomy of the Javanese species, in the 'Nova Acta,'—Mr. Griffith's observations in the 19th and 20th volumes of our Society's Transactions,—Schott and Endlicher's paper in the 'Meletemata,' and Weddell's paper in the fourteenth volume of Ser. 3. of 'Ann. Sci. Nat.,' are by far the most important. A very complete summary of other authors will be found in Unger's paper upon parasites in the Annals of the Vienna Museum; since which period, however, Gœppert's, Griffith's and Weddell's papers have appeared, as also Junghuhn's in the 'Nova Acta,' all of which are accompanied by valuable plates.

1. *Parasitism and Structure of the Rhizome.*

I shall employ the term rhizome for the principal axis of *Balanophoreæ*: it was

* Since the above was read before the Linnean Society I have examined several other collections, of which the most important are—10. The original specimens of *Langsdorffia* and *Helosis*, collected by Von Martius, and preserved at Munich; 11. those of *Scybalium* (which are to this day unique), in the Vienna Herbarium; 12. the valuable collection in the Jardin des Plantes at Paris. I have also to record my great obligations to my friend M. Weddell of Paris, who has already contributed so much to our knowledge of the plants of this Order, and through his good offices to the Museum of the Jardin, for specimens of *Lophophytum* in several stages of growth, of *Ombrophytum peruvianum*, of *Corynæa Weddellii*, and of *Langsdorffia rubiginosa*; all collected by Weddell in Bolivia, Peru and Brazil; for drawings of these made on the spot by himself; for dissections of *Sarcophyte sanguinea*, showing the central embryo which he discovered and figured, and for others of *Langsdorffia hypogæa* with the fruit fully formed, and which confirm Liebmann's drawings and descriptions of the fruit of that genus.

The result of the materials thus added has been to strengthen the views I have adopted of the structure and affinities of the Order, to enable me to classify *Sarcophyte* with *Monostyli*, and to reduce the subgenus *Lepidophytum*, which I had proposed, to the previously imperfectly known *Lophophytum*, with which I had doubtfully associated it.

I have also to express my obligations to our ingenious and accomplished foreign member M. Hofmeister of Leipsic, for showing me his drawings of the impregnated ovule of *Cynomorium*, with the pollen-tube in the foramen of the ovule: this, which is the most important discovery in favour of my view of the normal condition of the nucleus of the ovule and function of impregnation in the embryonate species, is also a most remarkable instance of skilful dissection. I am encouraged to hope that M. Hofmeister will take up the subject of the embryogeny of the *Balanophoreæ*, and need hardly add, that from his unrivalled skill as a phytotomist, and extensive acquirements in embryogeny, the subject will receive the fullest illustration at his hands.—December 4th, 1855.

suggested doubtfully by Richard, who however adopted those of "radix," "tuber," and "caulis:" it is the "axis" of Griffith; "rhizome" and "caudex" of Gœppert; "basilar receptacle" of Junghuhn, &c. In mode of origin and development it sufficiently accords with the definition of a rhizome, as usually employed in descriptive botany. In speaking of the root, I wish always to be understood as referring to that organ of the plant upon which the parasite grows.

The simplest and at the same time most frequent form assumed by the rhizome of *Balanophoreæ*, is that of a simple or branched tuber, sessile on the root from which the plant derives its nourishment, and giving off one or more flower-bearing peduncles. In the earliest stage at which I have examined any of the species, the young plant appears as a cellular mass, nidulating in the bark of the root (but partially exposed), with whose cellular tissue its own is in organic adhesion, though easily distinguishable. It offers at first no trace of a vascular system, nor any distinction of parts; but before it has reached the cambium layer of the bark, and before its upper extremity has attained any considerable size, an opaque line of white cellular tissue, different from the rest, may be found in the centre of the mass or beneath each of its lobes, in which vascular tissue makes its appearance. Shortly afterwards, the wood of the root upon which the parasite grows appears to become affected; its annual layers are displaced, and at a still later period vascular bundles, enclosed in a cellular sheath, are found in the axis of the rhizome, and are continuous with those already formed in it. For illustrations of these stages of development see Plates IV. & VI.

Some genera do not present the appearance of any vascular bundles communicating with those of the root-stock; but their own vascular bundles may be traced descending to the line of union between the root and the parasite, where they become closely applied to the vascular system of the former, without, however, forming any interlacement or organic union. Of this, *Lophophytum* and perhaps *Scybalium* are examples.

The fully formed rhizomes are roughly divisible into the simple, or merely forked or lobed, and those which are cylindrical, elongated horizontally and branched; forms which, though exceedingly dissimilar, and associated with very important anatomical details, are not accompanied by such modifications of the floral organs as would afford sectional characters in the Order; as a comparison of *Helosis* with its very near allies, *Scybalium*, &c., proves. The elongated rhizomes of some species form attachments by their ramifications to the various roots they encounter; and such never have foliaceous appendages, except at the bases of the peduncles or flowering branches. The amorphous or simple rhizomes again are often provided with scales (as in *Cynomorium*, *Lophophytum*, and *Sphærorhizon*), or with cellular papillæ (as some species of *Balanophora*). These papillæ consist of simple or divided extruded masses of cellular tissue traversed by a furrow; they are very numerous and cruciate in *B. dioica*, and are probably intimately connected with the aëration or respiration of the plant; they present nothing remarkable in structure, and resemble the rimæ with swollen lips on the spongy bark of some *Menispermeæ*, *Vitis*, and many other plants*.

* Junghuhn says (Nova Acta, xviii. Suppl. p. 223) that *B. globosa* is a species which he never found bearing these papillæ, except when it grew on the same root with *B. elongata*, when, like that species, it was always provided with them.

The rhizomes in many species attain a considerable age; but it is difficult to ascertain their duration after they have commenced flowering. *Helosis* seems to be capable of indefinite increase; the individual patches of the plant flowering at all or most seasons of the year, and the old branches of the rhizome dying as new ones are formed. In *Phyllocoryne* also, the large many-lobed rhizome seems perennial, and to flower at various seasons. In *Rhopalocnemis* and several species of *Balanophora*, it appears to me as if the rhizome continues to increase for several years; and then, after throwing up many peduncles in one season, to die the following autumn. Others however, as *B. involucrata*, which causes great knots to form on the roots of trees, either live many years and flower perennially, or else a perennial succession of young plants germinate upon the swollen root; a mode of increase suggested by the germinating specimen represented in Plate VI. fig. 8. In *Lophophytum* each tuber-like rhizome gives off only one or two peduncles, and the root on which it grows forms a shallow cup round its base; which I have found to be of many years' growth. *Cynomorium* appears to be decidedly annual, but I have not examined a sufficient number of specimens with the attachment preserved, to decide this point. *Langsdorffia* has certainly a perennial branching rhizome, and *Sarcophyte* a perennial tuberous one. Most of the *Balanophoræ* have lobed or branched rhizomes, which perhaps die after flowering.

In no case is the vegetation of the rhizome very rapid, in comparison with that of many plants; and especially of *Fungi*, with which some authors have compared them. On the contrary, I believe that the growth of all the parts is very slow; and with regard to *Rhopalocnemis* and *Balanophora* especially, I have had many opportunities of observing that the peduncle did not flower for several weeks after its protrusion from the rhizome.

The modes of attachment above indicated suggest another division of *Balanophoreæ*, namely, into—1. those in which the vascular tissue of the parasite is continuous with that of the root; 2. those in which the attachment is by means of the cellular system only; and 3. those in which bundles of vessels from the root terminate definitely in the parasite, a short distance from the point of attachment; the vascular systems of the two plants forming no evident confluence.

Of the first of these classes *Balanophora* and *Rhopalocnemis* are the best examples, from the great development of their vascular systems (which in some species present woody zones, a cortical system, and medullary rays), and from the fact that in many instances bundles of vessels appear to run in unbroken continuity from the woody system of the root to the very flowers of the parasite.

In the species of this first group, the appearance of the parasite having derived all its vascular tissue from the root has given rise to the hypothesis, that the whole production is an abnormal development from the root of the plant on which it grows:—thus Junghuhn quotes Trattinick (Linnæa, iii. p. 194) as saying of *Sarcophyte*, "hasce parasitas degenerationes plantarum specificas, sine seminum aditu creatas, modo spontaneo genitas;" and adds (Nov. Act. Acad. xviii. Suppl. p. 205), "Mihi Balanophorarum vegetatio fungosa est, originaria. Succi arborum, e quarum radicibus vivis sanisque *Balanophoræ* progerminant, nimis copiosi, cursu consueto perturbati, morphosin arboris redundantis, ut ita dicam, RETROGRADAM provocant, atque (directione vegetationis mutata) in novam et matricis naturæ alienam prolem consumuntur * * *." These theories have been well combated by Gœppert, who adduces the fact of the same species of *Balanophora* growing indifferently on various plants of very different natural families, as being quite opposed to them; to which may be added, that they have an independently developed vascular system of their own, which only in some species blends with that of the root; and that they are propagated by seeds.

Griffith does not seem to have traced the vascular bundles of the root into the peduncle of the parasite; for in his valuable paper on *Balanophora* (Linn. Soc. Trans. xx. p. 96), he describes them all as rising from the root into the rhizome, and terminating abruptly in the axis, towards its periphery: this well describes the appearance of those bundles which form the main body of the parasite; and they may be seen in the vertical section given in Plate IV. fig. 20, radiating in a fan-like manner from the root, and terminating in broad truncate masses towards the circumference of the rhizome. In a transverse section again (fig. 19) of a young, symmetrically formed, unbranched rhizome, with one peduncle, the vascular bundles will be found to be much more regularly disposed round a cellular axis, and separated by broad rays of cellular tissue.

Gœppert and Unger both consider that there is a double vascular system in the parasite; the one given off by the root on which it grows, and the other confined exclusively to the peduncle and its appendages, though passing downwards through the axis of the rhizome to within a very short distance of the base of the parasite, and there terminating abruptly.

The result of my own observations on live plants of *Rhopalocnemis* (and which were verified by Dr. Thomson), is that the vascular bundles of the peduncle are so intimately united with those of the rhizome towards the base of the latter, that they are organically one and the same tissue. In illustration of this I will refer to Plate IV. fig. 22, as being taken from one of the simplest and most symmetrical forms presented by a *Balanophora*: in this the letter *a* indicates the union of the vascular bundles of the peduncle and rhizome. Of *Rhopalocnemis* and *Balanophora dioica* I macerated many specimens in all stages of growth, some being in ripe fruit, when the vascular bundles have most consistence; and I never failed in dissecting them out in continuous masses from the bases of the apparent root-branches in the rhizome to the capitulum itself.

The vascular branches that connect the root with the rhizome of the parasite, are altogether analogous to those found in the exostoses of DeCandolle on the roots of various Leguminous plants; and especially such as have been pointed out to me by Prof. Henslow as being frequent on the roots of Laburnum*.

The root itself of the plant on which *B. fungosa* grows, has no pith (Plate VIII. fig. 15); but the branches which it appears to send into the parasite, enclose a pith (figs. 10 & 11 *a*), and the wedges of wood of which these branches are composed become broken up at a distance from the base of the rhizome (fig. 11 *bb*); the branches terminate in cylindrical masses of cellular tissue, enclosing a few imperfect spiral or barred vessels in their axis.

* These latter are coralloid masses, consisting of a cortical and woody system, the latter provided with obscure medullary rays: as their distance from the root is increased, their branches become simpler in structure, being merely cellular cylinders with a vascular axis or core, the latter consisting of a little pleurenchyma and very imperfectly developed annular and other vessels.

Two forms of attachment are found amongst the genera with branched and much-elongated rhizomes. In *Helosis* the rhizome forms a tuber at each point of its attachment to the various roots it meets with in its subterranean course, and a few vascular bundles from the root are rarely sent into it at these points; but these do not appear to communicate directly with the previously existing vascular tissue of the rhizome, nor to become blended with it: possibly, however, they may have been given off by it, or have been independently formed in the rhizome; a point which can only be determined by examining the nature of the attachment at its first formation, and which I shall hereafter discuss. In *Langsdorffia* the branch of the rhizome corrodes the bark of the roots it encounters; the first contact in the case of *L. rubiginosa* being by means of woolly hairs. Both the rhizome and the root generally swell considerably, but often do not, and the root sends long vascular branches, apparently covered with the cellular bark of the root, right and left into the axis of the rhizome; with whose vascular system, however, I have never found them to form an organic adhesion (see Plate II. figs. 10, 12, 13, 16, 17). In this genus two or more species of dicotyledonous plants sometimes send their roots into one tuber of an old rhizome, each penetrating at several points.

In the Annals of the Vienna Museum (ii. 53), I find *Balanophoreæ* arranged by Unger under three of the divisions, into which all parasites are separated by that author according to the nature of their parasitism; they are the following:—1. Parasites which form a rhizome by which they adhere to the roots of plants, and from which the flower-buds rise. Example, *Scybalium*. 2. Parasites which exercise a powerful specific action upon the root, causing it to send vascular bundles into the rhizome, which hence becomes an organ intermediate in nature between the stock and the parasite. Examples, *Balanophora*, *Sarcophyte*, *Cynomorium*, *Lophophytum* ? *Ombrophytum* ? 3. Parasites which form a rhizome intimately attached by its vascular tissue to the root. Examples, *Helosis*, *Langsdorffia*.

It appears to me that the above are rather distinctions of words than of facts; and that in so far as they are correct, any one of the three definitions is more or less applicable to all the species: for all form rhizomes, all owe their adhesion to their power of exerting a specific action upon the roots from which they derive their nourishment, and except in the case of *Lophophytum* (and perhaps of *Ombrophytum*, which I assume to have the same mode of parasitism as *Lophophytum*), all more or less present the appearance of the vascular bundles of the root being enclosed in the cellular tissue of the parasite. Further, if my observations are correct, both *Helosis* and *Langsdorffia* should be transferred to the first class; for there is certainly no distinct union of their vascular bundles with those of the root, nor do their rhizomes appear to send any bundles towards the root; on the contrary, the appearance is perfectly distinct of the root sending its branches into the rhizome. *Langsdorffia* indeed is described both by Richard and (apparently following him) Martius, as sending forth root-fibres from its rhizome; but I not only fail to discover these on any of the very numerous specimens I have examined, but I find this appearance to be produced by fibres being given off from the roots of the plant on which the parasite grows, which fibres become included within the rhizome (Plate II. fig. 11).

The differences therefore that prevail amongst the modes of parasitism of *Balanophoreæ*, are of degree only: the power of erosion and of forming an organic adhesion is the main point; that of inducing such a diseased action on the root as gives the appearance of the latter forming growths within the rhizome is a secondary one, and varies in amount; from *Lophophytum*, in which it seems to be none, to *Rhopalocnemis*, in which the bulk of the vessels in the rhizome are confluent with those of the root. As a general rule, the older the root attacked by the parasite, the fewer are the branches which it appears to send into the parasite; and as all my specimens of *Lophophytum* are on very much older and larger roots than are those of any other species, and indeed on wood of many years' growth, it is quite possible that in the case of its attacking younger and feebler roots it may develope the same power.

Under this view, the propriety of considering the rhizome of *Balanophora* and its congeners to be an intermediate body, as suggested by Unger, seems, as Gœppert has pointed out, to be erroneous; indeed, there are stronger objections to it than have hitherto been urged, derived from the development of that body.

I am unable to confirm Gœppert's observations on one extremely difficult point, namely the presence of the two wholly independent and unconnected systems of vascular tissue. This author maintains, 1. that no free vascular bundles originate in the rhizome previous to the formation of flower-buds, but that the root gives off bundles to the rhizome, within which they ascend, prolonging, increasing in diameter, and branching, with the corresponding development of the cellular system of the rhizome. 2. That on the formation of the peduncles (floral organs), free and independent vascular bundles are developed in them, which ascend as the peduncles elongate, and also descend into the rhizome, occupying a position between the vascular bundles of the latter, with which they do not unite. 3. That these independent vascular systems present anatomical characters by which they may constantly be recognized, at any rate in the individual species. These positions I shall examine consecutively, premising that it is with considerable diffidence that I venture to dissent from the conclusions of this eminent author, since though I possess the advantage of having repeated my observations, both on living and dead plants of several species, I cannot regard these as entitled to more consideration than M. Gœppert's known skill and accuracy*.

1. With regard to M. Gœppert's first observation, it must be remembered that he never had the opportunity of examining very young specimens, the importance of which desideratum he fully admits. In the section in Plate VI. figs. 7 & 8, which represents the independent formation of vascular tissue in a germinated *Balanophora involucrata* (and in other similar cases), I find in the axis of the rhizome pale transparent lines consisting of elongated cells, which contain no wax or cytoblasts, surrounding rudimentary vascular bundles. I have never examined a very young specimen in which these bundles were found to have descended to the vascular system of the root, but I infer that they do so, and, becoming incorporated with the vascular bundles of the root, present the appearance

* The difficulty of investigating these points is further far greater in living than in dead specimens: this is owing to the rapid sphacelation of the parts when cut, and the quantity of viscid Balanophorine (the term applied by Gœppert to the peculiar waxy secretion of *Balanophora*) contained in their cellular tissue, which prevents dissection with any approach to nicety: impediments so great, that I have no hesitation in saying, that in many cases better results may be obtained from specimens preserved in acid or spirits, than from living ones.

of having ascended from it, instead of having descended to it. This union once established, the difficulty of regarding the vascular bundles as originating in the parasite and drawing their nourishment from the root, appears to me less than that of regarding them as dependent both for origin and increase upon a reversed and diseased action of the root. The great theoretical objection to this view is, that the anatomical characters of the vascular bundles of the parasite precisely resemble those of the root, and that in some species they are even found to arrange themselves in the forms of woody plates and medullary rays, enclosing a pith axis, and to be surrounded by a cortical layer (Plate VIII. figs. 10, 11 *a*). It must however be borne in mind, that there is no law more universal in the vegetable kingdom than that vascular tissue is developed according to the requirements of the plant, both as to abundance and kind; and that the formation of a perfect organic cohesion between the walls of the individual cells of the cellular systems of the parasite and root, is in no respect less anomalous than the similar perfect and intimate organic cohesion between their respective vascular systems. As the rhizome increases, the organic cellular cohesion extends with the increased surfaces of the parasite and root, by the merismatic subdivision of the cells of both; and the vascular system increases by the development of pleurenchyma, ducts, &c. from those nucleated cells which are found in the positions in which vessels are required.

In a case of parasitism like that of *Balanophora*, which involves perfect organic cohesion between the individual cells of different plants, it must obviously in many instances be impossible to draw the line between the tissues of the parasite and those of the root on which it grows. With regard to the cellular tissues, however, there is generally no difficulty; for, that of the *Balanophora* containing organic compounds (wax), the line of union is evident; but it is different with the vascular systems, which consist in both cases of tubes of indefinite length, containing no solid organized contents, and presenting an extreme simplicity of form. Again, granting (as we must) that in *Lophophytum* (and in *Scybalium*, according to Unger's observations) the vascular tissue of the rhizome never descends to that of the root, and hence cannot form an organic cohesion with the latter, we must assume an independent origin for it in these genera, at any rate; the application of which to Gœppert's views involves the necessity of concluding that there are two fundamentally distinct principles of development amongst very closely allied species; namely, that the germinating plant of some does form independent vascular bundles (in common with all Phænogamic plants), but that that of others does not. To me it appears more in accordance with the known laws of development, to suppose that the origin of the vascular system is the same in both, but that its after-development is modified in different cases.

In *Langsdorffia*, where the rhizome has certainly a highly developed vascular tissue of its own, and where the root also appears to send branches into the rhizome, although I have never found the vascular system of the latter to unite with that of the root, I cannot but admit that such a union may exist, for the difficulty of dissecting the mixed brittle, woody, and flaccid tissues of this plant is very great.

The last argument which I shall bring forward in favour of considering the vascular system of the rhizome as in its origin proper to the parasite, is derived from the fact of free vascular bundles being formed in the flower-buds or nascent peduncles; which is conceded by Gœppert and all observers, and which is easily demonstrated. Hence, besides the difficulty of reconciling the theory of two origins for the vascular tissue in one plant to any known law, we must also break through the well-established law, that the formation of buds is a repetition of the process of germination.

2. M. Gœppert accurately describes the vascular bundles of the inflorescence as originating in the buds whilst still enclosed within the rhizome; but whereas he figures and describes them as having free terminations, I find them to become confluent with the vascular bundles of the rhizome. To any one versed in the dissection of vegetable tissues it can be no wonder that this is a point almost incapable of demonstrative proof in the solid, opaque tubers of *Balanophoreæ*, which generally turn of a deep brown when first cut, and become black in spirits; whose tissues cannot be torn; and in which the vascular bundles of the peduncle are so delicate, and run in such sinuous courses, that it is impossible so to bisect a plant that these bundles shall be traced continuously from the inflorescence to the base of the rhizome: I have, however, repeatedly found that the appearance of a free termination to the bundles is produced by cutting them obliquely across. A long maceration of the parts, and a careful picking away of the cellular tissues, are the only means I have found available for proving their confluence by direct observation; but at the same time I must confess that, whilst carrying on these dissections in various species of *Balanophora*, and in *Rhopalocnemis*, I have repeatedly changed my opinion, and indeed have on some occasions been almost convinced of the truth of the contrary view to that I have finally adopted, so deceptive are appearances.

In the tuberous *Helosideæ*, and in *Cynomorium* and *Sarcophyte*, the bundles of the rhizome are so unsymmetrically arranged, so much smaller in diameter, and so much more tortuous, that I have hitherto been unable to trace this confluence in them; whereas in both species of *Helosis*, and in *Langsdorffia*, which present the most perfect development of a cylindrical rhizome, the origin of the vessels of the peduncle in those of the rhizome is perfectly evident, and requires little skill in dissection to demonstrate.

3. With regard to the anatomical differences stated by M. Gœppert to exist between the vessels forming the vascular system of the rhizome and of the peduncle, they certainly do not exist in all the species. This is however quite consistent with Gœppert's analysis being perfectly accurate, for it is to be expected both that the vessels of the perennial rhizome should differ from those of the annual peduncle, and that from the form and direction of development of these organs being essentially different (the one chiefly increasing in breadth and the other in length), their vessels would be different also. In *Balanophora* the cellular sheath enclosing the vascular bundles is the same in the rhizome and peduncle (except that the individual utricles are longer in the latter); in both cases the cells are colourless, void of solid contents, and with few dots or markings on their walls; thus always contrasting strongly in appearance with the adjacent parenchyma, which abounds in wax. (See Plates IV., VI. &c.)

In the fully-formed flowering specimen of *B. involucrata* (Plate IV. fig. 1), I find no greater differences between the vessels in the rhizome and those in the peduncle than might be expected in organs so dissimilar in age and proportions. Plate IV. fig. 14. is a transverse, and 15. a vertical section of a vascular bundle from below the capitulum, composed of elongated cells which are more opaque towards the centre of the bundle; lower down in the peduncle they present the same appearance as is represented in figs. 26 and 27, which show vessels from the apices of the bundles in the rhizome. In fig. 22 some vessels of the rhizome, and on the left the base of one of those of the peduncle, are seen: at this part of their course both are regularly banded; which is better seen in figs. 23 and 24, where they are more highly magnified. Every intermediate form of vessel may be found between those represented at figs. 15 and 27; and occasionally in both organs the form of cellular tissue, seen at fig. 25, is found; which appears to be another modification, intermediate between the vascular and cellular, and which, in fig. 23, is placed outside the barred vessels.

In older specimens of *B. involucrata* much larger cylindrical vessels are found in the rhizome, mixed with hexagonal tubes with barred or otherwise marked sides, and bundles of pleurenchyma, which also occur in the peduncle, but in a much less perfectly developed state.

I find considerable uniformity in the microscopical character of the vessels amongst different specimens of *B. dioica*, although these have grown on widely different genera of plants (and the same remark applies to *Rhopalocnemis*); and I do not in any case find a more highly developed tissue in the peduncle than in the rhizome. On a comparison of my dissections of young specimens of *B. involucrata* with Gœppert's of old ones of *B. elongata*, the differences between them are perfectly reconcilable. Gœppert figures barred cylindrical vessels of cellular tissue as occurring only in the peduncle, and larger vessels with short transverse bars as occurring only in the rhizome; this I also find to be the case in old specimens; but in younger ones the barred cylindrical vessels are abundant in the rhizome, and comparatively rare in the peduncle; from which it may be inferred, that the said vessels are an imperfectly developed tissue.

In full-grown specimens of *B. fungosa* (Plate VIII. fig. 12), the same forms, relations, and modifications of vascular tissue prevail to a considerable extent; and the same may be said of other species which I have examined, though less in detail; whence I conclude that the anatomical differences between the vessels of the rhizome and those of the peduncle are dependent on position and degree of development.

The rhizome of the most perfect species of *Balanophoreæ* is decidedly exogenous. If a transverse section of the elongated one of *Helosis mexicana* be taken, the mass will be found to be composed of cellular tissue, enclosing (in the specimen given at Plate XV. fig. 14) a vascular system consisting of seven wedges, which surround a narrow cylindrical axis. Each of these wedges is (on a transverse section) narrow and oblong, and consists of many rows of annulate or transversely barred cylindrical or angular ducts, which occupy the position of the pleurenchyma of ordinary exogenous plants; outside of these is a reniform mass of stout, elongated liber-cells, into whose concave faces the outer ends of the wedges are thrust. Beyond the vascular system is a very thick spongy cellular mass continued to the circumference, where the cells are smaller and denser: this cellular tissue is everywhere interrupted by small masses of thick-walled sclerogen-cells, round which the cells of parenchyma radiate, and which, in a transverse section, resemble scattered liber-bundles. Surrounding the axis is a seven-lobed zone of stout sclerogen-tubes, the lobes of which project outwards as the bases of the medullary rays ; and between these lobes lie the axial ends of the vascular wedges. The following is a summary of these characters:—1. The axis is occupied by hexagonal cells, which become vertically elongated and woody (*see* 2.) towards the vascular wedges, and then radially elongated in the medullary rays, and pass insensibly into the membranous hexagonal tissue of the cortical portion: these cells contain grains of starch, and chlorophyll in abundance. 2. The woody tubes forming the outer zone of the axis (which is in many respects analogous to a medullary sheath) consist of long and strong cylindrical pleurenchyma, with much-elongated angular sclerogen-cells: these are all extremely hard, and their walls are perforated by innumerable canals. In old specimens the pith passes gradually into these tissues; its utricles becoming first cubical, with thick dotted or perforated walls; then becoming tubes elongated vertically; which are succeeded by tubes with blunt ends and narrow cavities. 3. The wood consists wholly of scalariform vessels which are cylindrical in young rhizomes, but polygonal with transversely barred or gashed walls in older ones; intermixed in every instance with smaller, more irregular and variously marked or perforated cells and tubes. 4. The liber-bundles consist of large, stout-walled, woody, hexagonal tubes, of great density; their walls everywhere perforated by canals. 5. The isolated sclerogen-cells in the cortical portion in no respect but shortness differ from liber.

Both in arrangement and in anatomical characters this description of the rhizome resembles in most particulars that of the stems of many *Menispermeæ*; and a more close examination bears out this resemblance.

In a transverse section of the peduncle of *Helosis mexicana* (Plate XV. fig. 12), eight symmetrically disposed vascular bundles are seen, and outside of these a few smaller irregularly scattered ones: and, as in *Balanophora*, the anatomical structure of the vessels composing these differs from that of the rhizome only in degree. The bundles consist of a sheath of elongated cellular tissue, enclosing a few fusiform vessels, some scalariform, others with spiral bands or transverse bars, with a few woody tubes and sclerogen-cells; and these may be traced up to the scales of the capitulum, to which scales much stronger bundles are given off than to the flowers.

In the rhizome of *Helosis guyanensis* (Plate XVI. fig. 30) I find—1. The whole pith formed of the same woody vessels as surround the pith of *H. mexicana*; and this both in New Grenada, Trinidad, and Rio de Janeiro specimens; these pass into a muriform tissue of woody tabular cells, which occupy the broad medullary rays, and of polyhedral cells still with very thick walls, in the circumference of the rhizome. 2. The wood is seen in a transverse section to be formed of seven lanceolate wedges of soft, white, scalariform, or spirally unrollable tubes. 3. A very large reniform mass of liber-cells or short tubes is placed outside each wood-bundle, and in contact with it. This does not seem to increase annually, but other and equally large liber-bundles form a zone exterior to these, and alternate with them; as in many *Menispermeæ*. 4. Isolated masses of sclerogen-cells and long liber-vessels are scattered throughout the parenchyma of the periphery.

The peduncle of *Helosis guyanensis* presents innumerable bundles of vascular tissue, composed of sclerogen-cells, spirally marked and scalariform vessels, and a few woody tubes, generally occupying definite relative positions. In a specimen of *H. guyanensis* from

Columbia the medullary system is much more utricular, lax, and membranous; but there are so many modifications of all these tissues in different specimens of the same species and parts of the same specimen, that it would be useless to multiply descriptions of them.

In all the other *Helosideæ* the same vessels are very conspicuous; but owing to the form of the rhizome they are confused in arrangement and variable in amount, frequently presenting no system whatever.

Langsdorffia presents the same exogenous arrangement in its rhizome as *Helosis*, but its axis (pith) is formed wholly of long wood-tubes (Plate II. figs. 5 & 6): its tissues are more particularly described under the remarks on the genus itself; where also its resemblance to the Indian *Balanophoreæ* in its waxy cell-contents is noticed.

Cynomorium has a rhizome which I have never seen to branch, though luxuriant specimens probably do so. The fusiform axis at the base of the peduncle, which is probably not the rhizome, but only the base of the peduncle, presents in a transverse section many small, unsymmetrically disposed vascular fascicles: each of these is composed of—1. towards the axis a bundle of delicate, white, cylindrical and angular, barred or scalariform vessels, or long polygonal cells with variously marked faces:—2. externally to this is a rather broad mass of vertically elongated oblong cells, of equal length; with blunt superimposed extremities, which all meet at the same height; giving this tissue a transversely marked appearance.

The tissues of *Sarcophyte* and *Mystropetalon* present nothing remarkable.

Cellular tissue.—This has been extremely well described in the Java species, by Gœppert, of whose remarks the figures of *B. involucrata* (Plate IV. figs. 7, 8, &c.) are illustrative. The walls of the cells are almost invariably dotted; in some cases owing to pores, and in others to deposits of wax and chlorophyll. Very frequently (and always in young specimens) each cell presents a conspicuous cytoblast, firmly adherent to a discoid spot. At Plate IV. fig. 11. are seen some of the waxy contents of the cells, in the shape of spherical or rounded nuclei of various sizes; full of utricles, which appear to burst, and scatter their granular contents within the cell, which is seen ruptured in fig. 13.

The wax of *Langsdorffia* and *Balanophora* is replaced in most of the other genera by starch-grains: these are especially abundant in *Sarcophyte*, *Cynomorium* and *Lophophytum*, which are in consequence eaten, as are other species occasionally*. The fluids of most of the species are colourless or pale yellow; those of the Indian *Balanophoræ* are quite white, and often very viscid.

I have never observed the appearance of the red cortical layer of the bark of the root, which Gœppert describes as ascending with and surrounding the vascular bundles of the rhizome in *Balanophora*, and which, he adds, contains tannin: it is, however, very conspicuous in *Langsdorffia*, and probably developed more or less in many other species. I have not found the raphides which he describes in the Javanese *B. alutacea*.

Unger calls the elongated parenchyma-cells with cytoblasts, "pseudo-pleurenchyma," and notices their similarity to vessels that occur in *Filices*; and he hence alludes to an affinity between *Balanophoreæ* and Acrogens. Gœppert also, considering that the cellular

* A chemical analysis of this wax is given by Gœppert, who calls it Balanophorine, and observes that it resembles the wax of *Ceroxylon andicola*.

tissues of *Balanophoreæ* are more uniform throughout the whole plant than in any other vegetables in which so abundant and high a development of cytoblasts occurs, is inclined to refer all Rhizanths to one class, which he would place amongst Acrogens, and near *Filices*. I need scarcely say that these feeble analogies do not appear to me to be of the smallest systematic value; so long as they are unsupported by definite characters, and that any such affinity is negatived by every other point in their structure and development.

The cuticle of *Balanophoreæ* never presents stomata, but is very simple in its structure, and formed of small cells, sometimes however of large vesicular ones, either isolated or in groups; as in *B. involucrata* (Plate IV. figs. 7 & 16): in other specimens clusters of bladdery cells form warts on the rhizome (fig. 16), which are arranged in lobed masses in *B. elongata* and others.

Hairs rarely occur on plants of this Order, though they are abundant on *Langsdorffia tomentosa*, and found on the flowering stem of *Thonningia*: in both genera they are unbranched, cylindrical, rather blunt tubes, with swollen and often bulbous bases, and more or less rough surfaces, and have thin walls and a large continuous empty cavity.

Sclerogen-cells, or *clostera*, abound in most of the species, and always present very thick, woody, perforated walls: they are especially conspicuous in the rhizome of *Langsdorffia*, in the cortical layer of that of *Lophophytum*, and in the leaf-scales of the latter plant, in which they pass into the form of tubular vessels.

Foliar organs.—No species is wholly deprived of these, though in some they are almost absent, and in others represented by scales on various parts of the plant; rarely on the rhizome, and most frequently on the capitulum, where they form more or less perfect bracts. There is, however, no obvious law for their development. In *Cynomorium* and *Lophophytum* they occur on all parts, from the rhizome to the apex of the capitulum. In *Langsdorffia*, *Thonningia*, *Balanophora*, *Scybalium*, and *Mystropetalon*, they are more or less highly developed on the peduncle, and very much reduced on the capitulum: in *Phyllocoryne*, they clothe both the peduncle and capitulum: in *Sphærorhizon*, they occur only at the base of the peduncle, on it, and on the capitulum: in *Helosis guyanensis* they cover the capitulum, but on the peduncle and at its base are reduced to a few small scales; whilst in *H. mexicana*, *Rhopalocnemis*, and *Corynæa*, they are almost confined to the former organ.

It hence appears that their chief development is upwards; the most rudimentary forms occurring on the rhizome at the base of the peduncle, where they compose the bud-scales; the most perfect on the capitulum, where they appear as bracts.

The bud-scales are numerous and imbricating in *Sphærorhizon*, and probably also in *Scybalium*; valvate in *Langsdorffia* and *Helosis guyanensis*; reduced to a volva or ring in *Balanophora* and *Rhopalocnemis*; and absolutely wanting in *Corynæa*. In most of the species the foliar organs are alternate; but in several *Balanophoræ*, in *Langsdorffia*, and *Helosis guyanensis*, those of the peduncle are whorled, and together form a cup; while they are reduced to an obsolete ring in *Helosis mexicana*.

Inflorescence.—The flowers are arranged in a uni- or bi-sexual spherical, oblong, cylindrical, or ovoid capitulum, in all the genera except in those of *Lophophyteæ* and in *Sar-*

rophyte, in which they occur in compound spikes or panicles. However simple these capitula appear, they are invariably found to be compound if examined at an early period of growth, when the bracts or scales imbricate completely over them, and cover definite masses of flowers, representing branches of the inflorescence. *Sarcophyte* presents the most perfect inflorescence, and the only one with a fully branched panicle; it has general bracts on the main axis below each ramification, but no partial ones. *Lophophytum* presents the next degree of perfection in inflorescence: each bract is a very highly developed peltate organ, subtending a cylindrical branch of the main axis, which is covered with flowers:—a modification of this arrangement is found in all the *Helosideæ*, and in *Cynomorium*, where the bracts are peltate and imbricate in a young state, and either peltate and attached by their margins, or scattered, in the older state.

In *Ombrophytum* the flowers are whorled round the pedicel of a very complete peltate bract, and in most *Balanophoræ* the female flowers are similarly arranged round a very rudimentary clavate one. In *Thonningia* and *Langsdorffia* the female flowers have no bracts whatever, and the male flowers very rudimentary ones. *Mystropetalon*, the most highly developed genus in many other respects, has a trifid bract under each flower, and no general bracts on the capitulum.

Articulated filaments occur abundantly over the whole surface of the capitula of most of the *Helosideæ*, and are probably rudimentary female flowers: their similarity to the paraphyses of *Musci* has been dwelt upon by Griffith, who (with some other authors) attaches great systematic value to this resemblance. These anomalous organs will be described under the respective species: analogous ones may be seen in the capitulum of *Langsdorffia*, and between the male flowers of some *Balanophoræ*. For further structural particulars respecting the inflorescence, the individual genera must be consulted.

The periods of inflorescence present some remarkable anomalies in *Balanophoræ*, and especially in the *Helosideæ* with bisexual capitula; a curious phenomenon, first observed by Richard (fully described by him under *H. guyanensis*), which necessitates the agency of dichogamy, or the fertilization of the ovaria of one capitulum or plant by the males of another.

Some genera are constantly diœcious; as *Langsdorffia*, *Thonningia*, *Rhopalocnemis*, *Sarcophyte*, *Lophophytum*, and some *Balanophoræ*; though in *B. dioica*, which is one of the most constantly so of that genus, I have occasionally found male capitula on the same rhizomes with female ones. The inflorescence is bisexual or monœcious, with the male flowers below, in some *Balanophoræ*: the male flowers are above in *Lophophytum* and *Mystropetalon*, and the two sexes are irregularly mixed in *Helosideæ* and *Cynomorium*, which latter occasionally presents also hermaphrodite flowers.

Flowers.—These present many gradations of perfection, both in the male and female. They are most fully developed in *Mystropetalon*, and the least so in the female of *Balanophora* and the male of *Lophophytum*.

The perianth, when present, is almost invariably dimorphous, and most perfect in the male flowers: in those of *Lophophytum* it is wholly wanting, or reduced to two opposite mamillæ alternating with the stamina; in *Thonningia* it consists of three minute scales which at no period cover the stamens; in *Cynomorium* it appears as six linear or clavate scales; in *Rhopalocnemis* it is tubular; in *Sphærorhizon* and *Corynæa* it is tubular below and campanulate above; in *Helosis*, *Scybalium*, and *Sarcophyte* it is tubular below, with three valvate segments; in *Balanophora* solid below, with three to eight valvate segments; in *Mystropetalon* it is irregular and oblique, of one free and two combined pieces, all valvate, and forming a tube below. The æstivation of the perianth is invariably valvate.

In the female flowers of all the genera but *Cynomorium*, the perianth differs very widely indeed from that of the male; as much so as in any Natural Order of plants. It is generally far less highly developed than the male, though more so in *Lophophyteæ* and *Thonningia*. It is assumed to be more or less adherent with the ovary in all the genera, but is perhaps totally suppressed in *Balanophora*, which presents the simplest possible form of female flower. In *Sarcophyte* the ovaries are immersed in a fleshy perianth, and all cohere into a solid capitulum. All the *Distyli* have two confluent ovaria, forming a one- or rarely two-celled pistil, and crowned by a two-lipped perianth; except in the case of *Lophophyteæ*, in which the limb is truncate or suppressed. In *Cynomorium* the six pieces of the perianth adhere to the ovary at irregular heights, being rarely wholly superior or wholly inferior. *Thonningia* and *Langsdorffia* have slender tubular perianths, which are solid below, and bear at their very base a small ovule, which is sunk in the fleshy capitulum: in the latter of these genera the female perianth much resembles the male, and its mouth is sometimes swollen and obscurely three-lobed. The female flower of *Mystropetalon* departs widely from the general type of the Order: the spherical ovary is seated on an oblate disc, and crowned by a small, campanulate, three-lobed, deciduous perianth, which may either be considered as the articulate free limb of the adherent calyx, or as a corolla. Analogy with *Halorageæ*, *Rubiaceæ*, *Compositæ*, &c., suggests the latter explanation, which however is opposed to the fact of there being no double perianth in the male flowers of this genus, or in any other plant of the Order.

Stamina.—The diversity of form so conspicuous in the perianth of different genera of *Balanophoreæ* is shared by the male organs, which agree in no point save the production of pollen. In *Lophophyteæ* the stamen is of the normal form, but only two in each flower, and without any other perianth than two mamillæ: the stamens have a very short filament and a long linear anther. In *Cynomorium* the stamen is solitary and of the usual form, but surrounded by a perianth, and subtended by a rudimentary style: in hermaphrodite flowers it is epigynous, and the filament is stout, attached to the anther by a very small point, and the anther is introrse. *Mystropetalon* presents the next modification, having three free stamens, each opposite a division of the perianth, and being similar to that of *Cynomorium*, but with an extrorse anther. *Sarcophyte* has three free stamens, opposite the valves of the perianth; they have fleshy filaments and adnate subspherical capitate anthers, full of polliniferous cavities. In all the remaining genera, viz. those of *Helosideæ*, *Thonningia*, *Langsdorffia*, and *Balanophora*, the stamens are opposite the lobes of the perianth; they are usually three in number, but vary in this respect; and are more or less confluent, both by their filaments and anthers. The dehiscence varies extremely, as does the number of cells. In all the species of *Balanophora*, *Langsdorffia*, and *Thonningia*, the anthers burst extrorsely, and have two or more loculi, which are confluent or anfractuose in some species of *Balanophora*: in all the *Helosideæ* they burst introrsely, and also by their apices, which decay away, and thus allow the pollen to escape.

The tissues of the anthers present little peculiarity; that of the connective is simply cellular, without any of the spiral vessels or beautiful modifications of banded or annulate cells, so conspicuous in the endothecium of many plants. It is frequently lined with a pulpy mass of mucilaginous filaments of excessive tenuity, which appears to be the remains of the tissue amongst which the pollen-cells were elaborated.

The pollen of various species has been carefully described by Gœppert, Griffith, and others, and presents nothing remarkable: it is generally spherical, often 3-lobed or 3-nucleate; in *Mystropetalon* it is polygonal. The surface of the extine is occasionally minutely granulated. Impregnation is probably mainly effected by insect agency, and at night; for during the day there is a singular want of insect life in the still, humid forests frequented by the species of *Balanophora*. I have, however, failed in many attempts to trace insect action; and a small *Acarus* feeding on the pollen of the monœcious *B. involucrata* is the only one I have found to be concerned in the operation, and that no doubt quite accidentally. The necessity of cross impregnation is manifest in the *Helosideæ*, as indicated by Richard, and elsewhere explained in this Essay (under the genus). The fact of insects forming a nidus in the fleshy plants of this Order, has been used as an argument in favour of insect action assisting in impregnation; but the same might be applied to any fleshy fungus or fruit.

Ovaries.—These vary in number, from one in the *Monostyli* and *Sarcophyte*, to two in the *Distyli*; and, according to Endlicher, to sometimes three in *Helosis* and *Scybalium*. When there are more than one, they are congenitally coherent, enclosed within the adherent perianth, and all the cavities but one are suppressed (being rarely present, according to Endlicher and Schott, in some flowers of *Helosis* and *Scybalium*), whilst the styles invariably remain, and are equal, and symmetrically disposed (right and left to the axis) at the summit of the perfectly symmetrical one-celled ovary. In those species which have a perianth, it may be traced surrounding the ovary, if examined before the latter begins to swell, and at all periods in some species; in most, however, the walls of the ovary become indurated, and blend insensibly with the adherent perianth, whose limb however generally remains, as the two-lipped calyx of the *Distyli*: in the *Lophophyteæ* it is truncate and suppressed; and in *Cynomorium*, *Mystropetalon*, and *Sarcophyte*, its structure has been already explained. Amongst the *Monostyli* the ovary is always one-celled; and in *Langsdorffia* and *Thonningia* it is enclosed in a very evident perianth. In *Balanophora* there are not even rudimentary traces of a perianth.

The style varies considerably in the Order. In *Balanophora*, *Langsdorffia*, and *Thonningia*, it is reduced to its simplest form, namely a cellular column composed of a very few oblong cells surrounding a soft, pulpy, stigmatic tissue; the latter does not form a distinct stigma, and the termination of the style scarcely differs from any other part of that organ. The pollen appears to take effect anywhere towards the apex of the style, and I have found pollen-tubes in the axis of the style. In the *Distyli* the style is usually capitate, and rather more perfect than in the *Monostyli*, terminating in a few larger, often globular cells. After impregnation, the walls of these cells, when very highly magnified, appear minutely wrinkled on the surface. The long single style of *Mystropetalon* terminates in a clavate or capitate, and evidently 3-lobed stigma. *Sarcophyte* has a sessile, broad, discoid stigma. The style of *Cynomorium* is more complex than in any other species, and terminates in a 2-lobed stigma; it is provided with two vascular cords and a central groove occupied by stigmatic tissue:—a detailed account of it will be found in the remarks upon *C. coccineum*.

In all the above-mentioned plants the cellular tissue of the ovary is very loose, consisting of oblong utricles, usually furnished with cytoblasts, and without any vascular tissue in its walls (except in the style of *Cynomorium*): there is, however, a manifest approach to vascular tissue in the woody cells of the superior perianth of *Thonningia*, and perhaps also of *Langsdorffia*.

Ovule.—This is invariably solitary, and pendulous from the summit of the cavity of the ovary. In both *Monostyli* and *Distyli* its insertion is so near the very centre of the cavity, that I cannot detect any deviation in its position from the axis of the ovary; nor in the *Distyli* do I find it to be placed nearer to one of the styles than to the other.

The earliest appearance of the ovule of *Balanophora* is as a solitary cell, protruded from the wall of the ovary: its subsequent stages I have followed to some extent in *B. involucrata*, though, owing to the rapid sphacelation of the cellular tissue of the ovary immediately after opening it, and the extreme minuteness of all the parts, the analysis is one of great delicacy, and proportionately liable to error.

Plate V. figs. 11 & 12. represent an opened ovary of *B. involucrata*, showing a very young ovule, consisting of a delicate hyaline sac suspended almost immediately below the insertion of the style, and containing two free spherical cells, each full of fluid and covered with opaque spots, which are probably cytoblasts. I found it impossible to detach the ovule, or to view it, except *in situ*, and by transmitted light. The formation of cells proceeds with great rapidity within the sac, but I was unable to trace their evolution. The resemblance between the cells thus developed, and those in the embryo-sac of ordinary ovules, is obvious, and it suggests the possibility of the ovule being reduced to an embryo-sac. I could obtain no clue to the period at which impregnation is effected, nor to the particular action of the pollen-tubes, which I never found within the cavity of the ovary or ovule*: nor could I trace on any part of the surface of the ovule, any indication of a chalaza, raphe, or foramen, at which impregnation is probably effected. After the ovule has swelled, so as to fill the cavity of the ovary, it adheres by means of its membranous coat to the walls of the ovary; at which time it consists of a dense opaque mass of cohering hexagonal cells.

The ovule, as thus described, does not materially differ from that of *Viscum*, as described in Decaisne's admirable memoir on that plant (Mémoires de l'Académie de Bruxelles), except in being more simple; the ovule of *Viscum* consisting of an embryo-sac covered by a delicate cellular membrane (the tercine of Mirbel), and the greater portion of the substance of its nucleus being undeveloped. Regarding *Balanophora* as presenting the most reduced form of ovule, *Loranthaceæ* are a step higher, and from these the passage is direct to the naked nuclei of *Santalaceæ* and their allies, of *Corneæ*, *Caprifoliaceæ*, *Rubiaceæ*, *Umbelli-*

* But which M. Hofmeister has observed in the ovule itself of *Cynomorium*.

feræ, and some others; and from these, through the single-coated ovules of *Menispermeæ*, many *Monocotyledones*, and other Orders, to the double-coated ovule of most Phænogams, and lastly to the three ovular integuments of *Gnetum*.

This rudimentary ovule can by no means be compared to the archegonium of a moss; nor does the reduction of the ovule to its simplest form argue any alliance between *Balanophoreæ* and *Cryptogamic* plants. The affinity which Griffith endeavoured to establish, is in this respect founded upon erroneous views of the origin and development of the ovule of *Balanophora*, with which he was not acquainted; and the development of this reduces the grounds of the argument to a casual external resemblance, or rude analogy, between two organs which are not homologous, and have no similarity of origin, structure, or function.

I very much regret my having been unable to trace the development of the ovule in any of the three embryonate and albuminous genera, *Sarcophyte*, *Mystropetalon*, and *Cynomorium*; and can only suggest that in them the albumen is endospermic, or developed within the embryo-sac, and not in the substance of the nucleus. The position of the radicle in *Mystropetalon* being close to the hilum of the seed, suggests the probability of the ovule being anatropous, and hence somewhat more complex than its congeners; whilst the lateral position of the embryo of *Cynomorium* is consistent with an obliquely pendulous ovule. Until, however, we become acquainted with the process of impregnation or the development of the ovule or the albumen, we have no materials for forming an opinion on the real nature either of the ovule or the seed. I have repeatedly dissected half-grown ovules of *Cynomorium* preserved in spirits, but never found a trace of any coats to the ovule, which always appeared as a membranous sac, full of cells as in *Balanophora*, and amongst which cells one is free, and from it the embryo is developed.

M. Weddell (Ann. Sc. Nat. sér. 3. v. 14) has also considered the ovule to be an embryo-sac, but he makes this opinion depend upon views of the nature of the ovary, style, stigma, and perianth, so different from my own, as to render our accordance upon this individual point purely accidental. I shall return to this subject after describing the seed.

Seed.—There are two types of seed in this order; the embryonate, and what has been called by various authors the exembryonate, and which has been described as consisting of a homogeneous or sporuliferous mass. The only known embryonate genera are *Cynomorium*, *Sarcophyte*, and *Mystropetalon*.

The seed is always pendulous from the summit of the cavity of the pericarp. The excessively thin testa contracts an intimate but not organic adhesion with the walls of the generally crustaceous endocarp, and is always so closely applied to the surface of the seed that it cannot be detached. This structure is very frequent in various Orders of Exogens, as in *Gunnera*, whilst there is a manifest tendency to it in *Araliaceæ*, *Boldoa* (a South American genus of *Monimiaceæ*), and other plants. In the exalbuminous species the substance of the seed is uniformly cellular; the cells, which are loose in the ovule, and fill the cavity of the pericarp previous to the swelling of the seed, become densely packed, probably from the cavity being limited in size, and its walls indurated before the seed has arrived at its full growth. When ripe, the seeds of most are densely corneous, especially towards the periphery. The comparison of the seed to a loose cellular mass, so frequently made by authors, probably in all cases arises from their having only examined immature specimens.

The individual cells of the homogeneous embryo are angular, with very thick transparent walls, and small cavities filled with a few chlorophyll-granules. I have never found starch in the embryo of any species; the contents of their cells being browned by iodine. Oil abounds in the exalbuminous species, and in the embryos of *Cynomorium* and *Mystropetalon.*

Hitherto the true nature of the exalbuminous, so-called exembryonate seed of *Balanophoræ* has eluded all research; nor till its germination has been traced*, is it probable that this point will be satisfactorily cleared up. In the mean time it may involve less of hypothesis to assume that the embryo is a homogeneous mass, in so far as any evident distinction of cotyledons and radicle is concerned, than to regard it as an albumen in which the embryo has not yet been discovered. Much may be said on both sides of this question; for instance, analogy with *Cynomorium,* in which the embryo is oily and the albumen not so, is in favour of the seed of *Balanophora* being considered to be embryo; on the other hand, if the cellular ovule of *Balanophora* so perfectly resembles the embryo of *Cynomorium,* it appears reasonable to conclude that the albumen of *Cynomorium* is endospermic, and developed in the same delicate sac with the embryo itself; against which view there appears no theoretical objection†.

* Impressed with the great importance of this point, I endeavoured, when in India, but uniformly in vain, to induce the seeds of *Balanophora* and *Rhopalocnemis* to germinate.

† Amongst the many Natural Orders whose homogeneous seeds or embryos present more or less analogy with those of *Balanophoreæ,* none have so close a similarity as those of *Triurideæ.* I have examined a species of this Order in a living state in the Khasia Mountains (East Bengal): its ovule (which has not hitherto been described) is manifestly anatropous, and consists of one integument and nucleus; offering one out of many proofs that the structure and position of the ovule in no degree influence the after-development of the embryo: in other words, that the development of the embryo, so far as its form and structure are concerned, is in a great measure irrespective of the presence or absence of envelopes to the embryonary sac.

Mr. Miers, in his valuable and elaborate paper on *Triurideæ* (Linn. Soc. Trans. xxi. p. 51) considers that it is consistent with the simplicity of the structure of other parts of the plants belonging to that family, "to expect a nucleus equally simple in its nature, formed merely of an aggregation of cytoblasts, which, under favourably-exciting circumstances, are endowed with the faculty of self-development." The true nucleus of the ovule in *Triurideæ* is however in no way different in structure or position from that of ordinary Phænogamic plants, from which it follows that although the embryo appears amorphous, its radicular extremity must be a determinate point with relation to the seed, and that in germination that end will elongate, and perform the function of the roots. The term "Protoblastus," therefore, as indicating an embryo that germinates from no determinate point, cannot under this view be adopted for that of *Triurideæ,* though, if it were proved that the germination of *Balanophoræ* (the structure of whose ovules does not reveal the position of the radicle) were from an indeterminate point, it might be more applicable to them. In both *Cynomorium* and *Mystropetalon* however, the radicular end of the embryo is very evident, and as there can be no doubt that the embryos of most or all *Balanophoreæ* germinate whilst still within the pericarp, it may be inferred that the radicle will protrude from a given ruptured point of the latter, and not indifferently through any part of its walls. Under these circumstances, I hesitate to adopt a term, which, in the present state of the inquiry, and as far as regards this order, implies, not that the germinating point is indeterminate, but that this, and the whole process of germination, are absolutely unknown.

With regard to other embryos which would come under the definition of a Protoblastus, that of *Orchideæ* evidently germinates from a given point; and Caspari's beautiful observations on *Orobanche* show that the same is the case in that genus. Blume describes the embryo of *Amorphophallus* as throwing out plumulary leaves from several points at once, which probably indicates a development of several much-reduced internodes crowded together, Richard (Mém. du Muséum, viii. p. 429), and latterly Lindley (Veg. Kingd. p. 85), have assumed the seed to be embryonate in all *Balanophoreæ*; arguing from that of *Cynomorium*, which both well understood; and I at one time adopted the same opinion, being much influenced by the fact that in certain plants with densely fleshy albumens, formed of large coherent cells, the embryo scarcely exceeds one such cell in bulk, and often eludes a very careful search; as that of *Mystropetalon* escaped Harvey, Griffith, and others. Yielding, however, to the mass of evidence in favour of the absence of any visible embryo within the seed of *Balanophora* and of all the *Distyli*, I am now inclined to agree with Griffith (Linn. Trans. xx. p. 93) in considering the embryo as a homogeneous mass, or "indivisus albuminiformis."

Endlicher (Meletemata, p. 9; and Gen. Pl. p. 73) describes the seed as a nucleus, "nucleo e tela cellulosa, massa sporacea farcta, conglobato," and adds that the testa is coriaceous, hard or subosseous, evidently mistaking the endocarp for a testa. Blume (En. Pl. Jav. i. p. 87) seems to have taken a similar view of the contents of the seed. Junghuhn, an ingenious and acute observer, says (Act. Acad. xviii. Suppl. p. 205), "Semina nulla adsunt; quod (supra) ovaria salutavi, vix nisi analoga sunt germinum plantarum perfectarum quæ nunquam maturescunt, sed more fungorum putredine pereunt." Trattinick also (Linnæa, iii. p. 194) says, under *Sarcophyte*, "that these plants are not developed from seeds, but are specific degenerations of the plants on which they grow."

Gœppert (Nov. Act. *l. c.* p. 257) considers that *Balanophoræ* grow from seeds, and describes these as "nuda exembryonata;" and Nees von Esenbeck (Nov. Act. *l. c.* p. 225) calls them acotyledones of a high class.

Liebmann (Proceedings of Assembly of Scandinavian Naturalists at Christiania) says of the seed of *Langsdorffia hypogæa*, that it is intermediate in character between a cryptogamic spore and a naked seed.

Martius (Nov. Gen. et Sp. iii. p. 186) regards the seed as an embryo, and states that he has seen small fibres given off from its basilar end, like rootlets; an observation not hitherto confirmed.

I have reserved to the last the discussion of M. Weddell's views, because they differ from those of other authors, and are based upon a comparison of an extensive range of organs, which cannot be considered separately; they are published in a paper read before the Société Philomatique of Paris, and more at length in the 'Annales des Sciences Naturelles' (sér. 3. xiv. p. 166): they especially refer to the relationship between *Balanophoreæ* and *Rafflesiaceæ*, and may be thus summed up:—

1. "The so-called fruit of *Balanophoreæ* is constructed on the same plan as the seed of *Rafflesiaceæ*; the so-called styles, which are almost always observable on that organ before its maturity, are appendages of one of the essential parts of the ovule. The fruit of *Balanophoreæ* must hence be regarded as a naked seed."

but all belonging to one axis. In Griffith's admirable paper on *Ambrosinia* (Linn. Trans. xx.), an extremely anomalous embryo is reduced to the ordinary type by a careful study of development and germination, and it is shown that though its parts are undistinguishable at first sight, each has its functions defined. It is remarkable that Griffith has not alluded to the strong resemblance between the embryo of *Ambrosinia* and the bulbils formed on the deformed inflorescence of several species of its near ally, *Remusatia*.

2. "The so-called flower of *Rafflesiaceæ* may be regarded as an inflorescence; the pericarp of the fruit is a receptacle, of which the folds form the placentæ."

It is not my intention to discuss the second of these propositions*, and I therefore confine myself to the first. In his descriptions M. Weddell states that the female reproductive organ of *Balanophora* is the nucleus of an ovule, and that of *Cynomorium*, *Helosis*, *Ombrophytum*, and *Sarcophyte*, a nucleus surrounded by a peculiar envelope, which is not a perianth, but is formed from the axis, and is to a certain extent analogous to the integuments (pericarp) of ordinary seeds: he was led to this conclusion by a comparison of the fruit of *Balanophora* with the seed of *Rafflesia*; and adds, that there is no more fundamental difference between the pericarp with its anfractuous cavity, of *Rafflesia* or *Hydnora*, and the convex or peltate receptacles of *Balanophora* or *Ombrophytum*, than there is between the receptacle of a fig and that of a mulberry.

In support of these views, Weddell contrasts the fruits of *Rafflesia* and *Balanophora*, and of *Hydnora* and *Sarcophyte*; but the comparison being maintained by the employment of the same terms for organs that do not appear to me to be homologous, the similarity becomes one of words, and not of facts. The term "styliform processes," for what other authors consider the styles of the ovary, and which analogy suggests to be such, appears to be the most anomalous; and by describing them as almost always present in *Balanophora*, it is implied that they are sometimes absent, which I have never found to be the case.

In commenting upon Griffith's theory that there is an analogy between the pistil of *Balanophora* and the pistillidium of *Musci*, Weddell points out that Griffith is in error in describing the styles as perforate, and adds in a note, "On reaching the periphery of the capitulum, this styliform process becomes eroded at the apex, when its internal cavity communicates with the external air: consequently the styliform process, being bathed in a mucous fluid that surrounds the capitulum, is exposed to the action of the fovilla of the pollen, which is mingled with that fluid, and fecundation is thus effected." In proof of this it is added, that in some diœcious species of the Order, which do not secrete this fluid, the ovules remain sterile; such at least being the case with *Langsdorffia* and *Helosis*.

Weddell is right with regard to the imperforation of the style, for at no period do I find an open canal in the style either of the American or Indian species; but neither do I find any erosion, or other arrangement of the organs by which I can conceive an erosion to be effected. The only fluid exudation I have seen on *Balanophoreæ* was a limpid watery one, on old capitula of *Rhopalocnemis*, after they had been removed from the ground; and this is a diœcious species, which was then in ripe fruit.

Lastly, the structure of the hermaphrodite flowers of *Cynomorium* (which M. Weddell was not acquainted with) is conclusive against the pistil being regarded as a naked ovule.

Affinities of BALANOPHOREÆ.

Polymorphism and an extreme simplicity in every organ are the prominent features of

* No explanation of the staminal apparatus in *Rafflesia* is given that is at all consistent with this view; and this therefore, as well as the presence of a discoid stigma, is adverse to the theory. Also, it is not shown how, if the seeds of *Rafflesia* are truly naked, the pollen is applied to the nuclei.

this Order, when surveyed in a structural point of view; and were value to be attached to the fact of every organ appearing in a most degraded state in one or more of the species, *Balanophoreæ* would rank low in the system of Phænogamic plants. If however we disregard imperfection, and inquire what organs are wanting in the Order, we shall find that, with the exception of terrestrial roots, all are present which are necessary to justify their being placed amongst Phænogamic plants.

The arguments which have been used to exclude *Balanophoreæ* from Phænogams, all appear to have originated on the one hand in mistaking feeble analogies between the forms of organs that are not homologous, for affinities; and on the other, in overlooking a multitude of positive characters. These arguments may be summed up as being:—

1. An erroneous view of the nature of the seeds, by Endlicher, Martius, Blume, and others, who describe them as a sporuliferous mass; a term which, even were it applicable, has no meaning.

2. An erroneous view of their origin being in a diseased state of the plants they grow upon; adopted by Junghuhn and Trattinick.

3. A supposed similarity in appearance to *Fungi**, and an erroneous idea that their appearance is meteoric, and their growth rapid; a theory advocated by Endlicher, who (Meletemata, p. 5) says of the horizontal rhizome of *Helosis* and *Langsdorffia*, "mycelio Fungorum quam maxime analogum."

4. The resemblance between the articulated filaments on the capitula of the *Helosideæ*, and the paraphyses of *Musci*; and between the pistilla of *Balanophora*, and the pistillidia of *Musci*; strongly advocated by Griffith and Lindley.

5. The resemblance of the cellular and vascular tissues in some of their characters to some of those of *Filices*; as indicated by Unger and Gœppert.

6. A very peculiar view of the nature and relations of the parts of the female flower, entertained by Weddell; who hence considers *Balanophoreæ* (together with *Rafflesiaceæ*) to approach nearer to *Gymnosperms* than to any other group of plants.

It would be fruitless to discuss these opinions at length; for it cannot be doubted that, had the authors who advocate them been sufficiently furnished with specimens and facts, they would never have been entertained. On the other hand, it is not easy to account for the little importance attached by so many good botanists to the positive evidence afforded by the presence of sexes, the perfection of the essential organs of the male flower in all the species, the total dissimilarity in structure and function between the female organs of all the species and those of Cryptogams, and their identity of structure in all essential points with those of other Phænogams.

With regard to the union of *Balanophoreæ* with *Rafflesiaceæ*, into one great class of Phænogams, equivalent to *Monocotyledones* or *Dicotyledones*, the arguments brought against it by Brown and Griffith are conclusive. Not only have these Orders no characters of systematic value in common, either physiological or structural, except parasitism, but they present positive evidence of widely different affinities; which in the case of *Rafflesiaceæ* have long been recognized. Thus, Linnæus himself referred *Cytinus* to *Asarum*; and Brown, Brongniart, and Griffith have all placed *Rafflesiaceæ* in close

* I may mention here that the species I have examined never became putrescent.

proximity to *Aristolochiæ*, an Order with which *Balanophoreæ* have not the slightest affinity. The arguments employed by Blume, Endlicher, Lindley, &c., for combining these Orders into one group, are also employed for removing both from Phænogams; the strongest reason for allying them being, not that they present characters in common, but that neither of them is considered to be allied to any other known Order of Phænogams.

Of the authors who consider *Balanophoreæ* to be Phænogamic, the majority refer them to *Monocotyledones*; Richard, and others following him, placing them in the neighbourhood of *Aroideæ*.

Griffith places them in *Dicotyledones*, and suggests their being the homogeneous embryonate group of *Urticeæ*; to which the structure of the *Distyli* is quite opposed: nor indeed does he endeavour to support this hypothesis by any arguments, but merely throws it out as a suggestion.

In my opinion, the arrangement of the vascular bundles in the rhizomes of *Helosis* and *Langsdorffia* is sufficient evidence of these plants being exogenous; for these, as I have elsewhere shown, are altogether exogenous, differ little from the stems of *Menispermeæ* and other anomalous, but still undoubted, Dicotyledons, and resemble no known Endogen in structure or arrangement.

In endeavouring to determine the affinities of *Balanophoreæ*, I shall disregard the negative characters, as those may be termed which are founded on the imperfection of organs; and I shall take the most perfectly developed species, as the best expositors of the typical structure of the Order. In so doing, I believe I am obeying a maxim supported by an attentive study of the natural system; for there are few Natural Orders, however perfect, that do not present structurally incomplete genera or species, many of which in point of development of their organs might rank below many *Balanophoreæ* and some Cryptogams; but which, nevertheless, are not departures from the type of their Order, but simply less developed forms of it.

Balanophoreæ have an adherent perianth in all the genera where this organ is developed, and an epigynous stamen in *Cynomorium*, the only species in which hermaphrodite flowers occur. These characters indicate a position amongst the epigynous *Calycifloræ*; a group which, though far from being well limited as a natural class, is in our present state of knowledge one of considerable value, as comprehending many nearly allied natural families. Amongst them, the most direct relation of *Balanophoreæ* is certainly with *Halorageæ*, and especially *Gunnera*; with which it presents many important characters in common, especially the valvate perianth and stamens opposite its lobes, and near which I would place it in the linear series.

A detailed comparison of the individual organs of a family so eminently polymorphous, with those of its allies, can alone establish its affinities: the more conspicuous of them are:—

1. Between *Cynomorium* and *Hippuris*, in the one epigynous stamen, on an ovarium consisting of one carpel with a solitary pendulous ovule and simple style.

2. Between the *Distyli* and *Halorageæ* a relation is established through the Australian genus *Loudonia*, which is a very peculiar form of the latter Order, having four styles, and

only one cell to an ovarium containing one or two pendulous ovules. This tendency to suppression of the ovaria, combined with the constant presence of their styles, and the styles of the suppressed ovaries being in all respects similar to that of the developed ovary, and equally perfect, is a very peculiar character, frequent in the *Halorageæ*, though not absolutely confined to them: it is very conspicuous in *Gunnera*. The greater tendency to imperfection in the female than in the male flowers of *Halorageæ*, is also a marked feature shared by *Balanophoreæ*.

3. Between *Gunnera* and *Lophophytum* the affinity is so close that the female flowers of these genera might be mistaken for one another; and the male flowers of *Lophophytum* in their two stamens, linear anthers and basal short filaments, are absolutely identical with those of several species of *Gunnera*: in the subgenus *Misandra* especially, the male flower often consists of two small sessile calyx-lobes, with two alternating stamens.

4. If the female inflorescence of *Gunnera* and *Lophophytum* be compared, the affinity may be very easily pursued: in each, short conical branches of the flower-head project laterally from a stout axis, and are subtended by a large bract, and studded with a dense mass of flowers, which consist of an adherent perianth, no trace of rudimentary stamens, two styles, and a one-celled ovary, with a pendulous ovule, whose integument, in ripening, contracts an adhesion to the inner wall of the cavity.

5 The tendency to a dimerous or tetramerous arrangement of the parts of the flower, so conspicuous in all *Halorageæ*, and in *Gunnera*, is common to the *Helosideæ* and *Lophophyteæ*.

Griffith has suggested an affinity between *Mystropetalon* and *Loranthaceæ*, founded on the form of the male perianth, and the opposition of the stamens to its lobes; but this is not borne out by the female flowers, which must be considered of the highest importance in establishing affinities. Griffith further was ignorant of the true structure of the seed of *Mystropetalon*, and supposed that the genus had no relationship with *Balanophoreæ*. After much consideration, however, I have included that genus in this Order, for reasons appended to some notes upon its structure; and in which view I am likewise following that taken by Mr. Brown (Linn. Soc. Trans. xix. p. 233, in note).

I have not dwelt upon the character afforded by the extreme dissimilarity of the sexes of *Balanophoreæ*, and which is also conspicuous in *Gunnera* and *Halorageæ*; because it is common to many other Orders, and indeed is perhaps a very constant accompaniment of reduction in structure, or of a normally imperfect development of the floral whorls.

Amongst the objections that may be urged against associating *Balanophoreæ* with the epigynous *Calycifloræ*, the strongest will probably be considered to be derived from the habit, and the imperfection of the foliar organs: with regard to the former, it appears wholly valueless, as will be proved by a cursory inspection of many Orders; and of these none are so conspicuous as *Halorageæ*, which, for its extent, is one of the most polymorphous in the vegetable kingdom, and further, one consisting for the most part of reduced forms of *Onagrarieæ*.

The extreme simplicity of the structure of the seed and ovule is another point of some importance, and may be used as an argument against the alliance I have proposed; but there is a manifest tendency to such imperfection in the epigynous *Calycifloræ*, especially amongst *Corneæ*, *Loranthaceæ*, and several other Orders in which the ovule is reduced to a nucleus. The homogeneous embryo is (as indicated by Brown and Griffith) a form of that organ which, if taken alone, appears to be of little value in a systematic point of view; for it occurs in various genera belonging to natural families which have, typically, highly developed embryos; and this argument is further weakened by the fact of *Cynomorium*, *Sarcophyte* and *Mystropetalon* having very obvious embryos immersed in albumen.

To parasitism, as a character of systematic value, I need scarcely allude; its invalidity being universally conceded.

As an Order, *Balanophoreæ* may in one sense be considered a strictly limited one, not passing directly into any other, except perhaps through *Gunnera* into *Halorageæ*; and forming a sufficiently natural assemblage of species, though, owing to causes I have repeatedly dwelt upon, not easy of exact definition. Putting aside any consideration of its relationship with other Orders, and regarding it *per se*, it is not easy to say whether it should abstractedly be considered as ranking high, or the contrary. Assuming that the conventional definition of perfection in use amongst zoologists is applicable to the vegetable kingdom, and which argues that a high degree of specification of organs and morphological differentiation of them for the performance of the highest functions, indicates a high rank, *Balanophoreæ* may in some respects be considered to hold a very high one. Thus:—

1. The monœcious and generally diœcious flowers show that either a whole plant, or a considerable portion of it, is specialized for each sex.

2. The great difference between the perianths of the sexes indicates a very high degree of morphological differentiation for each special function or sex.

3. The deviation of the parts composing the perianth of all the species from the common leaf-type indicates great differentiation.

4. The cohesion of the parts of the perianth in the male flower is a further deviation from that theoretical simplicity which assumes the leaves composing the floral whorls to be developed free from one another.

5. The cohesion of the anthers and filaments in most of the species is a further instance of specialization of the same nature.

6. The adhesion of the perianth of the female flower to the ovary shows its special adaptation as a protecting organ to be carried to the highest degree.

7. If it is safe to assume that either of the two perfectly equal and similar styles of the group *Distyli* is capable of conveying pollen-tubes to the solitary ovule, we have here a very remarkable case of specialization; for these two styles undoubtedly belonged originally to as many ovaries, though finally specialized for the use of one only.

As however is the case in all theoretical inquiries which are not based upon fixed principles, so in this as to the comparative rank of *Balanophoreæ*, there is much to be said on both sides. The reduced axis, the imperfect vascular system, the absence of leaves in many of the species, and their reduction to scales without stomata in the remainder, together with the invariable absence of a corolla, and of integuments to the ovule, are all evidences of a very low development. Whatever difference of opinion there may be as to the position of *Halorageæ*, of which I regard them to be reduced forms, it cannot be disputed that amongst Phænogams there are few groups so uniformly incomplete as regards the normal complement of organs, or the arrested development of those organs which are present. The value of this consideration is however much diminished by the fact, that there are no limits to the suppression of organs in the individual genera of Orders which are, nevertheless, typically highly developed.

In a systematic point of view, the value of these suppressions in the Vegetable Kingdom diminishes to a great extent in ascending from the root towards the ovary: thus, the absence of a root of the ordinary structure, and the adaptation of the lower portion of the stem to a parasitic attachment, occur in six or seven natural families of Exogens which are normally terrestrial, and perhaps in many more. A total absence of leaves, or a reduction of them to minute scales, occurs in many natural families. A reduction of the whole plant to a leafless, single- or few-flowered stem, is found in many parasites, and in *Orchideæ*, *Burmanniaceæ*, *Ericeæ*, *Scrophularinæ*, *Triurideæ*, *Rafflesiaceæ*, *Gentianeæ*, and other families which have no mutual affinities; whilst the reduction of the inflorescence to a single flower, and the parts of the latter to its essential organs, is too frequent to need specification. That of the embryo to a homogeneous mass is found in various genera, as indicated by Brown and Griffith: the reduction of the ovule to an embryo-sac is, however, in the present state of our knowledge, almost peculiar to *Balanophoreæ*.

As regards the including the *Monostyli* and *Distyli* under one Natural Order, these are so manifestly different, that it is a theoretical question how far, were there more genera of each, or had they a widely different geographical distribution, they would by common consent have been united into one natural family: and the same argument might indeed be applied with equal force to the removing *Mystropetalon* and even *Cynomorium*.

It is difficult to indicate any particular genus of *Balanophoreæ* which can be considered typical of the Order, though *Cynomorium* may be taken as such for the *Monostyli*, and *Helosis* for the *Distyli*. *Mystropetalon*, though in many respects the most perfect genus of the Order, cannot in any degree be considered typical of it; for it departs far more widely from the prevalent structure of its allies than any other genus does. Our ideas of what is or is not typical, are, however, vague and arbitrary; the ideal type being either the prevalent form of the group, or that which unites most of the peculiarities which distinguish it, or that which possesses the fullest complement of organs united in one individual, or that in which these are most complex, as well as specially adapted to the functions they perform.

Classification of BALANOPHOREÆ.

In the following arrangement of *Balanophoreæ*, I have been chiefly guided by the structure of the female flowers, which are generally found to afford the most important characters for systematic purposes.

The primary division into *Monostyli* and *Distyli* was proposed by Griffith (Linn. Soc.

Trans. xx. p. 103); who however erroneously refers *Rhopalocnemis* (*Phæocordylis*, Griff.), of which his specimens appear to have been imperfect, to the *Monostyli*. The genera of each group are all more nearly related to one another than to any of those of the other group; and such a division is therefore perfectly natural: but there are, notwithstanding, such very great differences between the members of each group, that the genera of *Monostyli* especially have all characters of far more than generic value, and may well be conceived to be types of very distinct assemblages of genera. This is not so much the case among the *Distyli*, for the two genera of *Lophophyteæ* are very nearly related, and those of the *Helosideæ* so much so, that it may be doubted how far *Corynæa*, *Scybalium*, and *Sphærorhizon* are distinct from *Helosis*.

Sarcophyte must at present be considered as in many points a doubtful member of the *Monostyli*, from my inability to discover whether the ovarium is simple or compound, at any period of growth. The absolutely sessile, discoid stigma is found neither in *Monostyli* nor *Distyli*, and in some other characters it partakes as much of one group as of the other; thus in its three stamens it agrees with *Balanophora* and all the *Helosideæ*, but it differs from them in its stamens being free, and in its anomalous anthers (which however suggest an affinity with *B. polyandra*). In its branched inflorescence it resembles *Lophophyteæ*, but differs totally in the structure of the male flowers.

For characters of secondary importance, I have availed myself of the male flowers, and especially of the number and form of the stamens and their cohesion. A remarkable analogy between two of the sections into which each primary group is divided, is established by these organs; the *Lophophyteæ* (of *Distyli*) having free stamens of the ordinary type of Phænogamic plants, and being hence analogous to *Cynomorium* and *Mystropetalon* (among *Monostyli*), while all the other genera have anomalous anthers.

In framing the genera, characters of the third degree of importance have been employed; such as the presence or absence of the perianth, and its structure; aided occasionally by the stamina, the cohesion of the flowers, the nature of the inflorescence, and lastly, the habit; this term implying in these plants not merely differences in the outline of organs, but also in their development and mode of evolution.

Besides Griffith's arrangement of *Balanophoreæ*, that of Endlicher (Meletemata, p. 4) is the only one of any importance hitherto proposed. His division is founded on the stamens being free or combined: this however not only assumes the position and arrangement of the stamina to be of more importance than those of the ovaria, but brings together genera which have otherwise little in common.

Geographical Distribution, and Variation.

The greater number of *Balanophoreæ* belong to the tropical and subtropical mountains of Asia and South America, where they probably occur in nearly equal proportions. In both hemispheres certain species ascend to 10,000 feet; comparatively few being found in low tropical forests, almost the only ones being *Balanophora fungosa* in the eastern, *Helosis guyanensis* in the western hemisphere, and *Thonningia* in Africa. A considerable number are extra-tropical; as *Cynomorium*, which attains lat. 41° N. in Europe; the two *Mystropetala* and *Sarcophyte*, which inhabit South Africa; *Helosis guyanensis*, which extends to the La Plata district; and the North Indian species of *Balanophora* and *Rhopalocnemis*.

The genus *Balanophora* is confined to India, and the Malay and western Polynesian islands: it extends from the N.W. Himalaya at Simla throughout that mountain-range to the eastward, thence to the Khasia Mountains, Burma, and the Malay Peninsula, Sumatra, Java, the N.E. coast of New Holland, as far east as the New Hebrides; it is also found in the Indian Peninsula, Ceylon, and the Philippine Islands, and no doubt occurs in Borneo and New Guinea. The *Helosideæ*, with the exception of the Indian *Rhopalocnemis*, are confined to the American continent and islands, where they extend from Jamaica and Mexico to the Pampas. Of the *Langsdorffiæ*, two species are American, and one (*Thonningia*) is found on the west coast of tropical Africa. The *Lophophyteæ*, as far as is known, all inhabit tropical South America, and are chiefly confined to South Brazil, Peru, and New Grenada.

The individual species of this Order have often exceedingly wide ranges, though some are extremely local. The most conspicuous examples of extensive distribution are: *Cynomorium coccineum*, which ranges from the Canary Islands to the mouths of the Nile, viz. through 3000 miles of longitude; *Rhopalocnemis* is found in lat. 27° N. in East Nepal and Sikkim, in the Khasia Mountains of East Bengal, and in Java, under the Equator, places no less than 3000 miles apart; *Balanophora dioica*, which has probably a still wider range; and *B. fungosa*, which is found both in East Australia and Tanna, places separated by 1500 miles of ocean. In the new world, *Langsdorffia hypogæa* has been found in the province of Oaxaca in Mexico, lat. 18° N., by Prof. Liebmann, in the mountains of New Grenada by Mr. Purdie, at Rio de Janeiro by many collectors, and in the Pampas by Mr. Miers (lat. 34° S.); having thus a range of 52 degrees of latitude, and 4000 miles in a straight line.

I do not find that the widely distributed species vary much according to the distance they spread; specimens from the most distant localities often being absolutely identical; and all being very constant to one form: on the other hand, some of the most local species as well as some of the most widely spread are excessively variable. As a general rule, the most imperfect forms vary most in general characters, especially *Balanophora*, the individual species of which differ in the size of their parts, in the form of their scales, their rhizome and their capitula, in the capitula being unisexual or bisexual, and in the size, form and number of the parts of the flower. *Helosideæ* again vary extremely in size and habit, but much less in the capitulum. *Langsdorffiæ* are rather variable, and *Cynomorium* is conspicuously so.

Balanophorearum Tabula Synoptica.

Div. I. Monostyli (Griff.). *Stylus* 1.

§ I. *Stamina* libera. *Semen* embryone et albumine instructum.

A. Mystropetaleæ.

Gen. I. Mystropetalon (Harv.). *Perianthium* fl. ♂ 3-partitum, 2-labiatum, segmentis valvatis, 2 anticis connatis; fl. ♀ epigynum, campanulatum, 3-lobum. *Stamina* 3, segmentis perianthii opposita, iisque inserta; antheris extrorsis. *Embryo* hilo proximus.—Pedunculus *solitarius, squamosus.* Capitulum *oblongum, bisexuale*; floribus ♀ *inferioribus,* ♂ *3-bracteatis.*

1. *M. Polemanni,* Harv.; bracteâ anticâ spathulatâ, perianthio ♀ tubuloso.
Hab. Africâ Australi.

2. *M. Thomii* (Harv.); bracteâ anticâ latè oblongâ, perianthio ♀ subgloboso.
Hab. Africâ Australi.

B. Cynomorieæ.

Gen. II. Cynomorium (Mich.). *Perianthium* utriusque sexus 6-phyllum. *Stamen* 1, in fl. ⚥ epigynum; filamentum in fl. ♂ basi stylo deformato suffultum; antherâ introrsâ. *Embryo* lateralis, hilo remotus.—Pedunculus *solitarius, squamosus.* Capitulum *cylindricum.* Flores *unisexuales, rarius bisexuales,* ♂ *et* ♀ *immixti*; bracteis *sparsis remotis.*

1. *C. coccineum* (Mich.).
Hab. Regione Mediterraneâ, et Insulis Fortunatis.

C. Sarcophyteæ.

Gen. III. Sarcophyte (Sparrm.). *Flores* dioici, ♂ paniculati; perianthii lobis 3, valvatis. *Stamina* 3, antheris multilocularibus, liberis. *Fl.* ♀ in capitulis globosis arctè cohærentes. *Stigma* discoideum, sessile.—Rhizoma *simplex, lobatum.* Pedunculus *nudus, ramis inflorescentiæ primariis basi bracteatis.*

1. *S. sanguinea* (Sparrm.).
Hab. Africâ Australi.

§ II. *Stamina* connata. *Semen* homogeneum?

D. Langsdorffieæ (Endl.). *Perianthium* fl. ♀ tubulosum.

Gen. IV. Langsdorffia (Mart.). *Staminum* columna cava. *Perianthii* fl. ♂ lobi 3, valvati, præfloratione genitalia includentes. *Antheræ* breves.—Rhizoma *horizontale, ramosum.* Pedunculi *terminales, squamis imbricatis tecti.* Capitula *unisexualia.*

1. *L. hypogæa* (Rich.); rhizomate glaberrimo v. glabrato.
Hab. Americâ tropicâ.

2. *L. rubiginosa* (Wedd. MSS.); rhizomate tomentoso v. lanato.
Hab. Brasiliâ et Guianâ.

Gen. V. Thonningia (Vahl). *Staminum* columna solida, infra medium squamis 2-6 aucta. *Antheræ* lineares.—Habitus *et* vegetatio *Langsdorffiæ.*

1. *T. sanguinea* (Vahl).
Hab. Africâ tropicâ occidentali.

E. Balanophoreæ. *Perianthium* fl. ♀ 0.

Gen. VI. Balanophora (Forst.). *Perianthium* fl. ♂ 3–6-phyllum. *Antheræ* extrorsæ. Fl. ♀ pistilla bracteolis clavatis immixta v. pedicellis bractearum inserta.—Rhizoma *tuberosum v. ramosum*. Pedunculi *nudi v. squamosi*. Capitula *unisexualia v. bisexualia*. Flores *unisexuales*.

α. Pedunculi squamis in cupulam v. involucrum connatis.

1. *B. involucrata* (n. sp.).
Hab. Himalayâ temperatâ.

β. Pedunculi squamis alternis v. imbricatis; antheris 3–6 2-locularibus.

2. *B. dioica* (Brown); capitulis unisexualibus cylindricis, rhizomate tuberoso lobato pustulis lobulatis instructo.
Hab. Sylvis montosis subtropicis Indiæ borealis, Bengaliæ et Birmæ.

3. *B. elongata* (Blume); capitulis unisexualibus subcylindricis, rhizomate elongato ramoso ramis cylindricis pustulis lobulatis instructis.
Hab. Montibus temperatis Javæ et Peninsulæ Indiæ orientalis.

4. *B. Indica* (Wall.); capitulis unisexualibus, ♀ obovoideis globosisve, pedunculis elongatis, rhizomate tuberoso lobato.—(An *B. globosæ* var.?)
Hab. Sylvis montosis subtropicis Peninsulæ Indiæ orientalis et Ceyloniæ.

5. *B. globosa* (Jungh.); capitulis unisexualibus, ♀ globosis, pedunculis brevibus, rhizomate tuberoso lobato.—(An *B. abbreviata*, Blume?)
Hab. Sylvis temperatis Javæ.

6. *B. fungosa* (Forst.); capitulis bisexualibus ovoideis subglobosisve, rhizomate tuberoso lobato granulato.
Hab. Orâ orientali Australiæ tropicæ, et Ins. Novæ Hebrides dictis.

7. *B. alutacea* (Jungh.); capitulis bisexualibus cylindricis, rhizomate lobato lævi, pedunculi squamis paucis vaginantibus.
Hab. Sylvis tropicis Javæ et Ins. Philippinis.

γ. Pedunculi squamis alternis v. imbricatis; antheris multilocularibus.

8. *B. polyandra* (Griff.).
Hab. Sylvis montosis subtropicis Himalayæ orientalis et Khasiæ.

Div. II. Distyli (Griff.). *Styli* 2.

F. Lophophyteæ (Endl.). *Stamina* libera.

Gen. VII. Lophophytum (Schott & Endl.). *Flores* secus ramulos pedunculi mamillæformes apice obtusos congesti, mamillis basi bracteis deciduis suffulti.—Rhizoma *crassum, supernè squamis imbricatis tectum*. Pedunculus *basi nudus*.

1. *L. mirabile* (Schott & Endl.); paleis cum floribus immixtis v. 0; stylis 2 elongatis breviusculisve.
Hab. Brasiliâ.

2. *L. Bolivianum* (Wedd.); paleis inter flores 0, stylis 0 (an delapsis?).
Hab. Cordillerâ Boliviæ.

3. *L. Weddellii* (n. sp.); floribus dioicis, paleis inter flores 0.
Hab. Cordillerâ Novæ Granadæ.

Gen. VIII. Ombrophytum (Pœpp. & Endl.). *Flores* secus pedicellos bractearum peltatarum congesti.—Vegetatio *et* habitus *Lophophyti, sed squamæ nullæ*. Pedunculus *basi volva v. annulo circumdatus*.

1. *O. Peruvianum* (Pœpp. & Endl.).
Hab. Cordillerâ Boliviæ et Peruviæ.

G. Helosideæ (Endl.). *Stamina* connata.

Gen. IX. Scybalium (Schott & Endl.). *Rhizoma* tuberosum, lobatum. *Flores* pedunculis distinctis squamis imbricatis tectis monoici. *Capitula* convexa v. planiuscula. *Perianthium* ♂ 3-lobum.

1. *S. fungiforme* (Schott & Endl.).
Hab. Brasiliâ.

Gen. X. Sphærorhizon (n. g.). *Rhizoma* tuberosum, indivisum. *Pedunculus* solitarius, squamis deciduis tectus. *Capitula* sphærica v. oblonga. *Perianthium* ♂ 3-lobum.

1. *S. curvatum* (n. sp.).
Hab. Novâ Granadâ.

Gen. XI. Phyllocoryne (n. g.). *Rhizoma* lobatum v. ramosum. *Pedunculi* plurimi squamis persistentibus subhexastichè imbricatis tectum. *Capitula* cylindracea v. oblonga. *Perianthium* ♂ 3-lobum.

1. *P. Jamaicensis* (Cynomorium Jamaicense, *Sw.*).
Hab. Ins. Jamaicâ.

Gen. XII. Rhopalocnemis (Jungh.). *Rhizoma* tuberosum, simplex v. lobatum. *Pedunculi* pauci v. solitarii, basi annulo v. volvâ instructi. *Capitulum* oblongo-cylindraceum. *Perianthium* ♂ tubulosum.

1. *R. phalloides* (Jungh.).
Hab. Sylvis montosis Himalayæ temperatæ orientalis, Khasiæ, et ins. Javæ.

Gen. XIII. Corynæa (n. g.). *Rhizoma* tuberosum, simplex v. lobatum. *Pedunculi* solitarii v. pauci, basi annulo v. volvâ obscurâ instructi. *Capitula* sphærica v. oblongo-cylindracea. *Perianthium* ♂ campanulatum.

1. *C. crassa* (n. sp.); capitulo cylindraceo.
Hab. Montibus temperatis Novæ Granadæ.
2. *C. sphærica* (n. sp.); capitulo rhizomatis fossâ sessili sphærico.
Hab. Montibus temperatis Novæ Granadæ.
3. *C. Purdiei* (n. sp.); capitulo sphærico pedunculato.
Hab. Cordillerâ Peruvianâ.

Gen. XIV. Helosis (Rich.). *Rhizoma* cylindraceum, ramosum. *Pedunculi* plurimi, nudi v. basi v. medio annulati. *Capitula* ovoidea, oblonga v. globosa. *Perianthium* ♂ 3-partitum.

1. *H. Guyanensis* (Rich.); pedunculis basi volvâ v. involucro 5–7-phyllo instructis medio nudis.
Hab. Americâ tropicâ.
2. *H. Mexicana* (Liebm.); pedunculis medio v. supra medium annulo obsoleto instructis.
Hab. Americâ tropicâ.

I. Mystropetalon, Harv.

(Tab. I. B.)

1. Mystropetalon Thomii, Harv. in Ann. Nat. Hist. 1839, vol. i. p. 386. t. 19; Griff. in Linn. Soc. Trans. vol. xix. p. 336.

I have little to add to the excellent descriptions of Harvey and Griffith, except with regard to the embryo, which I have found to be constantly present in the ripe fruit; it is clavate, placed at the upper part of the seed, lying quite loose in its axis, with the radicle pointed to the hilum, and close to it. The albumen-grains are oleaginous, large, loosely coherent, and enclosed in a delicate cellular membrane. I find no membrane enclosing the embryo, which is pale, transparent, and formed of minute cohering cells, and is not oleaginous. The apex of the stigma is obscurely 3-lobed: there is no very distinct stigmatic canal; but the cells of the stigma and centre of the style are soft and pulpy.

Griffith, who did not detect the embryo of this plant, considered that this albumen (which he describes doubtfully as an embryo) suggests a greater resemblance to a sporuliferous mass than is shown by any other so-called Rhizanth: it is remarkable that this observation should refer to one of the only three known plants of the Order, of which the truly albuminous nature of the great mass of the seed is indisputable; and is an example of the inexpediency of assuming an organ to be anomalous because its structure is unexplained.

The inflorescence of *Mystropetalon* differs from that of other *Balanophoreæ* in the male flowers being at the summit of the capitulum, and the female below. In the monœcious *Cynomorium* and most monœcious *Helosideæ* they are promiscuously mixed, with the males generally lowest; in monœcious *Balanophoreæ* the males are normally at the bottom of the capitulum; though I have seen traces of male flowers at the apex of a capitulum of *B. involucrata*.

Mystropetalon is certainly in all respects the most highly developed genus of the Order, both from the complexity of the floral envelopes, and from the presence of a perfect embryo, placed in the usual position of that organ in Phænogamous plants. It was referred to *Balanophoreæ* by Harvey and by Mr. Brown (Linn. Soc. Trans. xix. p. 233, in note*); and though very anomalous in its greater perfection, must remain as a section of that Order, or in close proximity to it. Griffith considered it as *sui ordinis*, but with great sagacity indicates its affinity with *Cynomorium* (a plant he had not examined), and finally described it (doubtfully) as the homogeneous-embryo form of a group of plants including *Loranthaceæ, Proteaceæ, Santalaceæ*, and other Orders comprehended in Lindley's alliance *Tubiferosæ*. Considering the very great structural and morphological differences presented by *Balanophoreæ*, it becomes impossible to exclude *Mystropetalon* from the Order; of its affinity with which there are many positive evidences, and the curious negative one of extreme dissimilarity between the perianths of the sexes. Of positive characters, the most conspicuous besides habit, are, in the male flowers, the valvate 3-partite perianth, tubular below, and enclosing a rudimentary ovarium, the stamens opposite the segments of the perianth, and the extrorse anthers; in the female flowers, the epigynous monosepalous perianth, the deciduous style, the structure of the walls of the ovary, the extreme simplicity of the ovule, and the adherent membranous coat of the seed. It departs from all the rest of the Order in its male flowers being normally above the female; in its very unequal male perianth, its frequently imperfect odd stamen, and angular pollen; in the ovarian disc, deciduous perfect female perianth, 3-lobed stigma, presence of an imperfect pistil in the male flower, and axile clavate embryo. Considering its monostylous ovary, with a tubular perianth, its nearest ally would appear to be *Langsdorffia*, between which and *Cynomorium* it will rank in a linear series.

* The species there referred to does not appear to me to be specifically distinct from *M. Thomii*.

II. Cynomorium, Mich.

(Tab. I. A.)

1. Cynomorium coccineum, Mich.—Ad citationes evulgatas adde, Linn. Amœn. Acad. iv. 351. t. 2; Webb, Flor. Ins. Canar. iii. 431; Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 176. t. 11.

Though this curious plant has received so much illustration from many able botanists, there are still some points in its structure which are little known; and there are points in Linnæus's description in the 'Amœnitates Academicæ,' which have, I believe, escaped most subsequent observers.

The geographical range is very remarkable: it extends from the Canary Islands to the Levant; *i.e.* over fully fifty degrees, or 3000 miles of longitude. I have examined specimens from its extreme eastern and western limits; namely, from Lancerotte and from the delta of the Nile; and I have compared these with others from various intermediate localities, as Oran, Malta, Sardinia, S. Spain, and Sicily; and I have found no traces of any differences that suggest the propriety of establishing even varieties. It is also found in Etruria, lat. 41° N. (its northern limit), Lampedusa, and Tunis according to Linnæus.

Cynomorium is not singular amongst *Balanophoreæ* in this wide distribution; though it is more local and scarce than any of its congeners which occupy an equally extensive area. It is the only species known to inhabit a dry climate and soil, and is no less remarkable for delighting in the immediate neighbourhood of the sea, and growing in salinas, and often on saline plants (Linn.). Mr. Webb informs us (Hist. Ins. Canar. Bot. vol. iii. p. 431) that it is eaten in the island of Lancerotte.

In a young state the lower part of the peduncle is remarkably distinct from the upper; it is broader, fusiform, and covered with short, broad, acuminate, imbricating, spirally arranged scales (well shown in Micheli's plate), giving it a polygonal appearance: these scales are much less conspicuous in the old plant, and are probably very deciduous; whence the discrepancy that Richard remarks between his Egyptian specimens and Micheli's figure. The lower portion of this contracts suddenly at the point of union with the root-stock, and there is, I believe, a well-developed rhizome; but I have no complete specimens of it. The parasitism consists in an intimate organic adhesion between a small surface of the cellular tissue of the *Cynomorium*, and the wood of the root on which it grows; but no vascular tissue (at any rate in the old state) unites the latter with the parasite.

The vascular system (represented by Unger, Ann. Wien. Mus. ii. t. 5. f. 32) consists of many bundles irregularly scattered through the peduncle and capitulum; forming waving lines, but never crossing or resembling the endogenous type in structure or arrangement. These, in a transverse section, are seen to consist of two kinds of vessels; namely, 1. internally of a small bundle of delicate cylindrical or angular white tubes with transverse marks or bands; 2. a broader dark external tissue which in a transverse section appears cellular, and in a longitudinal one is found to consist of many series of linear, superimposed, oblong cells, regularly placed, and all terminating at the same plane, thus giving a barred appearance to the tissue; the contents of these are all highly coloured.

Besides these there are thick-walled pleurenchyma-cells. The cellular system, which forms by far the greater mass of the plant, consists of large polygonal utricles, with thin transparent walls, full of starch and chlorophyll granules.

The scales upon the upper part of the peduncle are broader than those at the base; blunt, often transversely oblong, peltately attached, and, on the capitulum, gradually assume the character of peltate bracts. In the youngest specimens I have examined (Tab. I. A. fig. 1) long before the flowers are discernible, except as lobed papillæ, the appearance of all the scales from the base to the top of the plant is remarkably uniform; they are broadly ovate, acuminate, and imbricated at the fusiform swollen base, more scattered and broader, and blunter or truncate, on the upper contracted portion of the peduncle, and again acute and densely imbricated from the base to the summit of the capitulum, the surface of which they wholly conceal. At this early period the scales are very obliquely peltate; in a vertical section each is seen to curve upwards and cover the lower part of the peltate scale immediately above it, whilst the lower part is produced into a long incurved lobe. The lower lobe presents a semi-lunar curve towards the capitulum, and arches over a mamilla of the capitulum covered with nascent flowers. The concave upper surface of the next scale below is closely applied to the dorsum of the lower lobe of that above it. A strong vascular cord enters each scale, and is united at a little distance from its base, within the body of the capitulum, with an equally stout cord from the mamilla above it. It will thus be seen that each scale forms the protecting organ to a definite mass of flowers below its point of insertion, but is connected by its vascular system with the mamilla of flowers above it; an arrangement similar to that which occurs in *Lophophytum* and some *Lycopodiaceæ*, but which can in *Cynomorium* only be discovered at a very early period.

Owing to the much more rapid growth of the capitulum than of the scales, these eventually become scattered, at the same time losing their bracteal form, and becoming broader and fleshy. These changes are precisely the same in their nature as occur in the bracteal scales of *Helosis* and its allies. The paleæ which occur abundantly amongst the flowers, and vary extremely in form, consist of rudimentary flowers, both males and females, and of perigonial leaves, removed from their flowers by unequal growth. There is a disposition in some of the floral scales of larger size than the rest, to assume the position of a bractlet under each flower, or group of flowers.

The male and female flowers appear promiscuously in succession for a considerable period: in this respect *Cynomorium* presents a remarkable contrast to *Balanophora* and *Helosis*, &c.; as in these the evolution of the sexes occurs at different times: and it is worthy of remark that this phænomenon is perhaps confined to this genus, and is therefore peculiar to the only plant of the Order which exhibits a strong tendency to hermaphroditism.

In Webb's 'Flora of the Canary Islands' (iii. 431), I have described hermaphrodite flowers of *Cynomorium*; which were pointed out to me by Mr. Brown in a drawing of Bauer's: they were originally discovered by Linnæus (Gen. Plant. ed. 5, 1754), and described by him; as indicated by Richard, who, however, failed to find them himself.

The palea of Richard, surrounding and half enveloping the stamen of the male flower, is a remarkable organ: from analogy with *Balanophora*, *Helosis*, and indeed the majority of the Order, it might be considered an imperfect perianth; whereas in the hermaphrodite flowers it is seen to be a well-developed style, the ovary of which is usually suppressed. In these flowers the stamen rises from near the summit of the ovary, above the insertion of any of the perigonial scales, and the base of the filament is lodged in a narrow vertical canal immediately opposite the concave face of the style (figs. 3, 4 & 5). I have not been able to ascertain the position of the style and stamen with reference to the axis of the plant; but, considering the simple nature of the pistil, and that the flowers are collected in groups, representing theoretically ramifications of the inflorescence, I assume that the concave face of the style is opposite to the ideal axis of each such ramification.

In the youngest state of the male (fig. 6), the floral envelopes are often symmetrically disposed. A spathulate palea subtends each flower, and within it are six perigonial scales; these are frequently perfectly regular, and form a verticil round the rudimentary ovarium and filament: the whole flower afterwards grows with great rapidity, and some of the perigonial scales are left at its base, while others are carried up on the elongating imperfect ovarium, which resembles a pedicel, and branching bundles of vessels are developed in their axes. The style at the same time elongates rapidly, but increases also in breadth upwards, so as to resemble a perigonial scale much more than the style of the female flower does; it has however no vascular tissue. In some male flowers all the perigonial scales remain symmetrically disposed round the filament and style, till the flower has attained its full development.

At the earliest period the female flowers (fig. 2) appear as compressed, pedicelled bodies, subtended by a bract similar to that of the males. The pedicel dilates, and divides into two (rarely three) linear perigonial leaves, and again contracts, forming the base of a compressed obovate ovary, on whose summit is the broad linear style, somewhat contracted immediately below the papillose stigma; and at its base are three other linear blunt perigonial leaves of equal size, which are always symmetrically disposed, two being placed right and left in the same plane as the style and the two lower perigonial leaves, and one at the dorsum of the style. Two vascular cords are seen, one on each side of the ovarium, meeting at its base in the pedicel, and again at its summit immediately at the base of the style, below which an opaque circular spot marks the cavity of the ovary; these vascular cords again separate in the style, and are free to its apex. The base of the style is contracted, and of a very dark colour at the contraction: I am not aware what this indicates. The opacity is also seen at the base of the filament in hermaphrodite flowers, and often upon all the perigonial scales, at a point exactly corresponding to the base of the style.

During the growth of the female flowers, the perigonial scales do not attain the development they do in the males, nor do they generally contain vascular bundles. They become variously displaced; some remaining on the summit of the ovary, and others being more or less basal, or adnate to its surface. In the adult female flower a small cellular protuberance may often be seen on the summit of the ovary (fig. 7), fronting the concave face of the style: this may be a rudimentary stamen.

The hermaphrodite flowers present both the pistil and stamen in as perfect a condition as they attain in the unisexual flowers. The situation of the perigonial scales varies as much in these as in the female flowers, but though they never attain the same development as they do in the males, they approach it, and often contain vascular cords. In one hermaphrodite flower (fig. 9) I found six perigonial scales, symmetrically disposed round the summit of the ovary.

There is thus in a complete flower of *Cynomorium* a superior perigonium, an epigynous stamen, a pistil consisting of one carpel with one simple style, and one pendulous ovule, succeeded by an albuminous seed:—characters common also to *Hippuris*, and indicating an affinity I have elsewhere noticed, and endeavoured to support by the structure of other *Balanophoreæ*.

I may here repeat what I have stated in the 'Flora of the Canary Islands' concerning the pistil of *Cynomorium*; namely, that the simple concave style with two parallel vascular cords terminating an ovary which undoubtedly consists of one carpellary leaf, is a strong evidence of the compound nature of a style of the simplest type; and that the two lateral stigmata are here perfectly obvious: which agrees with Mr. Brown's remarks on the composition, &c. of the pistil* (Plant. Jav. Rar. p. 110 in note). The stigmatic tissue runs down the mesial line of the style, occupying the canal, and is covered by a very delicate epidermis.

I have never succeeded in tracing the development of the ovule in *Cynomorium*. The structure of the ripe seed has been determined by Richard, Lindley, and Weddell; but admits of some little further illustration. In the first place, the embryo when fully ripe is considerably larger than is figured by any of these authors, and is never exactly globular, but sometimes broadly conical, the narrow end being placed next to the firm cellular integument of the seed. It consists of large cells with dark nuclei, full of oil, and presents no integuments whatever: it lies in a cavity of the albumen, nearer the base than the hilum of the seed, with its radicle pointing rather downwards; and it faces the same way as the concave or grooved surface of the style; thus indicating that the ovule, if perfect, would have been semi-anatropous with the raphe on the side removed from the placenta; a view confirmed by M. Hofmeister's observation of the pollen-tube in the foramen of the ovule.

The albumen is of exceedingly firm and dense structure, consisting of thick-walled angular cells with dark-coloured granular chlorophyll-grains. Dr. Lindley found starch in these cells, which is probably present in the young state only, when he describes the albumen as mucilaginous, and the cells as loosely arranged. I could not detect any, either microscopically, or by the iodine test, which, when applied to the most delicate slices of fully formed albumen, turned its granular cell-contents brown. Mr. Weddell states that the albumen as well as the embryo contains oil (Ann. Sc. Nat. *l. c.* 178): "dans les *Balanophora*, dans le *Cynomorium*, et dans le *Sarcophyte*, j'ai rencontré un albumen charneux ou huileux, et un embryon de même nature."

* On showing Mr. Brown my analysis of the style of *Cynomorium*, he informed me that this was a case he had had in view, and that he considered it strongly confirmatory of his theory.

III. Sarcophyte, Sparrmann.

(Tab. I. C.)

1. Sarcophyte sanguinea, Sparrm. in Act. Holm. xxxvii. p. 300. t. 7; Schott & Endl. Melet. Bot. p. 11; Griffith, Linn. Soc. Trans. xix. p. 339; Unger, Ann. Wien. Mus. ii. t. 5. f. 28; Weddell in Ann. Sc. Nat. sér. 3. p. 14. t. 10. f. 34–38.

Ichthyosma Wehdemanni, Schlecht. in Linnæa, ii. 671. t. 8.

Hab. Africâ Australi, ad radices *Ekebergiæ* prope Grahams-town (*Wehdemann*, &c.). Ad radices *Acaciæ Capensis*, Quagga's Flat, Uitenhage (*Zeyher !*).

My observations on this remarkable plant chiefly refer to two points: the structure of the anther, and the relation of the genus to other *Balanophoreæ*, in both which I differ from Mr. Griffith.

The anther is rightly described by Endlicher as consisting of a solid capitate body, containing many loculi filled with pollen. The contracted persistent septa between these loculi have been mistaken by Griffith for pedicelled anthers, which he describes as forming together a "caput antherarum," crowning a common peduncle, which rises from the axil of a bract. On the contrary, I find that the anther* contains about fifteen to twenty cells of very variable size, radiating from a cellular axis: a transverse section shows about twelve such cells symmetrically disposed round the apex of the filament; and a vertical one exhibits about eight, which radiate from the blunt summit of the filament, and of which the outermost are very small. At a very early period the septa consist of three tissues: an inner cellular not materially different from that of the filament, from which, however, it is separated by a broad dark line; this is lined by a delicate hyaline endothecial coat, and upon this is a mass of matted filaments of excessive tenuity and pulpy nature precisely similar to the anther-lining of *Phyllocoryne*, &c., amongst which the pollen-grains nestle. Each cell is distended with spherical pollen-grains.

I have not observed the circumscissal dehiscence of the outer membrane described by Endlicher, and which was apparently suggested to that author by the appearance of an annulus at the base of the dehisced anther; as on the contrary the anther dehisces by the disruption of the membrane over each loculus, in a manner quite analogous to that of the apices of the anthers of *Rhopalocnemis*, *Helosis*, and *Corynæa*, on the one hand, and of *Balanophora polyandra*, &c., on the other; and is an instance of the general tendency to dehiscence by irregular disruption of the anther-wall, which prevails throughout the Order. I have not been able at any period of its growth to reduce the anther to the ordinary 4-locular type; the pollen being developed, as in *Viscum* and various *Rhizophoræ*, simultaneously in many independent points of the epithelium: that these points originated along definite lines, answering to the position of anther-cells of the ordinary type, can therefore only be assumed.

From the above it is evident that Griffith is perfectly correct in insisting (*l. c.* p. 339) that a continuous solid tissue must exist between the cells of the anther, if it be assumed that these cells are not separate anthers.

In assuming that the filaments of *Sarcophyte* are axillary to the lobes of the perianth

* A correct section of the anther is given in Unger's paper; Ann. Wien. Mus. *l. c.* t. 7. fig. 48.

(which he hence considers bracts), rather than bodies forming a verticillus on an inner and different plane, Griffith overlooks the fact, that their position in no way differs from that of the stamen of other *Balanophoreæ*, and that all stamens opposite to and seated at the base of perigonial leaves, are in the same category. On the other hand, his argument against the stamens being axillary, because they do not appear to form an inner whorl, may be equally applied against considering the perigonial leaves as being bracts, for the latter decidedly do form an outer whorl, and are all on one plane; a fact which, as well as that of their decidedly valvate æstivation, is opposed to their bracteal origin.

Another remark of Griffith's is to the effect, that "the analogies of *Balanophora* are in favour of Endlicher's generic character; but that it requires a very exalted idea to be held of the value of parasitism, to conceive any affinity between *Sarcophyte* and *Balanophora*" (p. 340). If, however, the homologies in the structure of the flowers are admitted, it cannot be said that systematists have depended on an undue value attached to parasitism, for the supposed affinity; and in the second place, the argument derived from parasitism, if of any value, does not rest upon the mere fact of parasitism, but on that of the root appearing to send vascular bundles into the rhizome of *Sarcophyte* as it does into that of other *Balanophoreæ*, a kind of parasitism not hitherto detected in any other Natural Order*.

The male flower of *Sarcophyte* differs in no essential particulars from that of *Balanophora*; the pedicel (tube of perianth) and three valvate perigonial leaves being identical, and both having the stamens opposite to the latter. The chief difference is, that in *Balanophora* the stamens are united by their filaments and connectives, whilst in *Sarcophyte* they are free. The suspected analogy between the structure of the stamen of *Sarcophyte* and the sorus of *Cyathea* and *Sphæropteris*, suggested by Griffith, is under any view quite untenable.

Griffith's description of the ovarium and its contents does not accord with my observations; nor could I suggest any explanation of his "brown central nuclei, containing one, or not unfrequently two, other brown nuclei;" but Weddell points out that Griffith examined an abnormal state of the fruit, which he has frequently observed himself, and in which the embryo is abortive, and the albumen and integuments become confounded into an ossified mass. I find, in the ovarian cavity of specimens preserved in acid, an immature ovulum, consisting of loose white cells, enclosed in a delicate membrane as in *Balanophora*. This albumen and its crustaceous coat (formed of the pericarp) are well illustrated by Weddell (Ann. Sc. Nat. *l. c.*), as is the central embryo, discovered by himself.

Griffith goes too far in stating that the female flowers of *Sarcophyte* are widely different from those of *Balanophoreæ*, in their greater general perfection, the union of the ovaria, and the obvious stigmatic surfaces: for, in the structure of the female flower, and of the seed, except in the development of the embryo, they are identical: the more highly organized stigmata attain a greater degree of perfection in *Sarcophyte* than in those genera with which

* Except *Orobanche*, the germination of which has been so admirably illustrated by Caspary (Regensburg Flora, 1854, p. 577, t. 3). It appears most probable that the germination of *Balanophoreæ* will prove very similar to that of *Orobanche*.

Griffith was best acquainted, but not so great as in *Cynomorium* and others; whilst the greater general perfection in other respects, to which he alludes only, I do not appreciate. The union of the ovaria does not indicate a difference in the female flowers, but a different inflorescence; a point of much less systematic value, and indeed of none in *Balanophoreæ*, as is proved by a comparison of *Balanophora*, *Cynomorium*, *Lophophytum*, and their allies. In this point the analogy is perhaps complete with *Thonningia* and *Langsdorffia*, whose ovaria are entirely united; as are the perianths of *Langsdorffia*, in some states at any rate. As an indication, however, of the female flowers of *Sarcophyte* being furnished with a perianth, this point is of considerable importance.

Another fact connected with the inflorescence of *Sarcophyte* is the sudden suppression of bracteal scales; these, which are very conspicuous at the base of the primary branches of the male and female inflorescence, are not developed at the base of the capitula, or of the individual male flowers. This appears, further, opposed to Griffith's supposition that the perigonial leaves of the male flower are bracts, though perhaps not conclusive against it.

The tissues of the stem of *Sarcophyte* are full of starch-granules, but do not differ otherwise from others of the Order, though in the peduncle the vascular bundles are very irregularly deposited. The roots of the plant upon which it grows are connected by stout woody branches with the rhizome of the parasite; and there seems to be a complete fusion of the vascular tissues of both.

IV. Langsdorffia, Rich.

(Tab. II.)

1. Langsdorffia hypogæa, Martius in Eschwege's Journal von Brasilien, ii. p. 179; Nov. Gen. et Sp. iii. 181. t. 199; Unger in Ann. Wien. Mus. ii. t. 4. figs. 21 & 22, & t. 7. fig. 40.

Langsdorffia Janeirensis, Rich. Mém. Mus. viii. p. 412. t. 19; Endl. & Schott. Meletem. p. 12.
Thonningia Mexicana, Liebmann in Proceedings of Assembly of Scandinavian Naturalists, 1844.
Sendfenbergia Moritziana, Klotzsch & Karsten, Herb. Mus. Berol.
Hab. Americâ tropicâ, a Mexico ad Brasiliam meridionalem. Sylvis montis Serra d'Estrella (*Martius*); Rio de Janeiro (*Miers*, *Gardner*, *Stephan*). Sylvis montosis provinciæ Oaxaca, Mexico (*Liebmann*); *fl.* Nov. Dec. Ad radices arborum ad Tucouroma, provinciæ Ocanæ (*W. Purdie*); Colombia (*Karsten*).

After a very careful examination of specimens from all the localities quoted above, except the male and fruiting specimens of Martius and Prof. Liebmann, I have referred all to one species. As however this is a very important point, involving the question of the range of the species extending throughout the tropics of both Americas, I feel that it is necessary to dwell at length upon it. From Mr. Purdie I have large suites of specimens, which show that the capitula on the same rhizome vary quite as much as those of Mexican specimens do from Brazilian ones. Prof. Liebmann, in his *résumé* of the characters distinguishing the Mexican plant, seems chiefly to rely upon a comparison of it with the drawings and descriptions of that from Brazil; but I find that none of my Brazilian specimens agree in all their details with Martius' and Richard's drawings; nor do these quite accord with one another, but only in what I assume to be mere individual, and not specific characters.

Prof. Liebmann sums up the differences between the Mexican and the Brazilian individuals, as residing in the more globose female capitulum, shorter stem, more shortly pedicelled perianth, twisted style, binate paleæ of the male receptacle, which are also clavate and dilated at the base, white papillose (male) perianth, longer filament, globose synema and globose pollen. It is also added, that the anthers are 2-celled, and dehisce differently, leaving a triangular opening between them, and that the filaments are free immediately below the anthers.

With regard to these points, I find the capitulum if anything more depressed in the Mexican plant and in Liebmann's accurate figure of it, than in Richard's drawing of the Brazilian, or than in most of my specimens either of the Brazilian or Colombian plant. The stem (peduncle) varies extremely in length, from ½ an inch to 8 inches, and considerably even on the same rhizome. The perianths of Mexican specimens are much longer than those of Liebmann's figure, and they are of the same length as those of my Brazilian specimens, though shorter than in Richard's or Martius' figures. The styles of the Mexican plant are very slightly twisted, and that from left to right, not the opposite way, as represented in Prof. Liebmann's figure; and there is the same twist in Mr. Purdie's and in some of the Brazilian specimens. The perianths seem constantly papillose, though varying in degree with age, drying, and other less obvious causes. Globose pollen is the common form in the genus.

Of the remaining distinctive characters, I have occasionally found binate paleæ of the described shape both on *L. hypogæa* and *tomentosa*; the filament in Liebmann's figure is so extremely short, that it appears impossible to draw a character from it; the synema varies in form, according to its age, and that represented in the figure of *T. Mexicana* entirely agrees with Brazilian individuals; and finally, the anthers of all, though 4-celled in their early and perfect state, become 2-celled previous to dehiscence, by the contraction of the septum. I therefore feel justified in referring the *Thonningia Mexicana* to *Langsdorffia hypogæa*.

The parasitism of *Langsdorffia* is remarkable: the dichotomously branching rhizomes appear most frequently to corrode, as it were, the bark of the roots they encounter, which they even sever, and then enclose the end that remains attached to the parent plant: the root swells considerably at the junction, and appears to send prolongations of wood into the rhizome of the parasite, which run along its axis for several inches; but though there is an intimate union between the wood of the root and the cellular tissue of the parasite, there seems to be no blending of their vascular systems. The rhizome also invariably swells at the junction, but does not branch from that point, as is often the case with *Helosis*. Both Richard and Martius represent rootlets as given off from the rhizome at a considerable distance from any parasitic union; but I do not find such in any of my specimens, nor have any other *Balanophoreæ* rootlets, though at the junction of root and parasite similar rootlets to those figured by Martius are often given off by the root, and these being partially enveloped by the parasite, appear to proceed from it. Martius and Langsdorff further say that the plant grasps other roots by means of these fibres, and that it does not appear to be really parasitical; but in both these points I think these authors are mistaken.

In Purdie's specimens of *L. hypogæa*, which are immature, the female perianths adhere firmly, so that their tissues are torn in sundering them. I have not found this to be the case in the Brazilian or Mexican specimens. The style varies exceedingly in length, as does the perianth of the female flower and its pedicel; the mouth of the perianth is obscurely lobed, and a few slender, straight, rigid, woody tubes traverse it longitudinally, as in *Thonningia*.

In common with Richard and Von Martius, I have sought in vain for any traces of the cavity of the ovarium. For a knowledge of the fruit I am indebted to Prof. Liebmann's invaluable communications, and to specimens given me by M. Weddell. The two former authors indeed hazard the supposition that all the specimens they examined were of a barren state of the species; to which, if such were the case, would have to be added upwards of fifty specimens examined by myself. Considering the extraordinary minuteness of the seed, it seems safer to conclude that the cavity of the ovary being still smaller, sunk in the substance of the fleshy receptacle, and probably filled with the ovule, which adheres to the cavity, it has escaped observation*. The fruit-bearing receptacle is quite similar to that of *Thonningia*; it dilates greatly after flowering, causing the surrounding scales to spread horizontally; its surface is covered with the persistent fleshy conical perigonia, which adhere so closely that they may be removed in a body as a fleshy covering to the receptacle. Beneath each flower is a minute oblong seed, nidulating in the fleshy receptacle, and pendulous from the apex of a unilocular crustaceous putamen. The seed is compressed, oblong, covered with a membranous coat, and has an evident raphe down one of the edges. The specimens I have examined are immature and had no discernible embryo, as were probably those examined by Liebmann, who describes the contents of the seed as a pulpy mass of globular cells. The clavate scales of the male capitulum appear to me to be undeveloped female flowers; and the small, hard, prominent, imbricating scales which surround the base of the female capitulum, are connate articulate filaments, analogous to those of *Helosideæ*.

This species yields so large a quantity of wax, that candles are made of it in New Grenada. The secretion is contained entirely in the cellular tissue, where it appears as a large opaque mass in every utricle. Mr. Purdie informs me that near Bogota the stems are collected, and sold in the markets under the name of *Siejos*, and used as candles on saints' days.

* Since writing the above, I have examined some excellent flowering specimens of *L. hypogæa*, which, though originally preserved in spirits and afterwards transferred to acid, have not turned brown; and in these I find unimpregnated ovules. The perianths in these specimens adhere firmly throughout the upper two-thirds of their length, but their cylindrical bases, though densely packed, are quite free. Their substance is very loosely cellular and diaphanous, and a dark spot immediately above the insertion of the flower on to the fleshy capitulum, marks the position of the excessively minute ovarian cavity and ovule. Owing to the extreme minuteness and laxity of the cellular tissue of the ovary, I had great difficulty in opening it and dissecting out the ovule, which forms a pendulous globular transparent sac, consisting of a few loosely packed nucleated cells, enclosed in a membrane of excessive tenuity. This ovule is the most minute that I have met with in the vegetable kingdom. I further found pollen-tubes in the style of some flowers, traversing a conducting tissue formed of long, soft, lax, tubular cells in the axis of the style.—Kew, March 4, 1856.

On the Tolima range it is called "Belacha;" and "Melonsita" on the mountains around Bogota, where its soft receptacle is eaten when ripe, and considered stimulating and refreshing. It is remarkable that *Langsdorffia*, the only monostylous American genus, should resemble *Balanophora* in the abundance of its waxy secretion; whilst *Rhopaloenemis*, the only distylous Asiatic species, resembles the other American *Helosideæ* in the absence of wax.

2. Langsdorffia rubiginosa, Weddell (Ann. Sc. Nat. sér. 3. xiv. t. 11. f. 48–51), rhizomate densè tomentoso. (Tab. II. figs. 1–19.)

Hab. Sylvis montosis regionibus superioribus fluminis Orinoco, alt. 3500 ad 4000 ped. (*Schomburgk*, *Ic. Pict.*): locis umbrosis humidis inter Quebradas de San Juan et Panones, Parana de Ruiz (*Purdie*): provinciâ Goyaz Brasiliæ (*Weddell*).

This species does not seem to have been distinguished from *L. hypogæa* by Mr. Purdie, from whom I first received it, and who mentions its also being used for candles. It in every respect resembles *L. hypogæa*, except in the dense, matted, woolly vesture of the rhizome, which appears as if wrapped in wool. This indumentum is formed of long, simple, very sparingly articulated transparent hairs, with broad bases and blunt apices, and walls covered, especially towards the base, with minute granulations; they are quite hollow, and very flaccid. All my specimens are males, and have very short peduncles, clothed with rather narrower scales than in *L. hypogæa*. The small clavate bodies situated on the male capitulum, and placed at the angle where four flowers meet, are often connate: they are quite analogous to the similarly placed organs in diœcious *Balanophoræ*. Weddell figures the female perianths as connate throughout their length, as is sometimes the case with *L. hypogæa*; his specimens appear to be immature, and I doubt its proving eventually distinct from the last-mentioned species.

V. Thonningia, Vahl.

(Tab. III.)

Conophyta, Schum. *Hæmatostrobus*, Endl. MSS. (Gen. p. 76).

Dioica. Fl. ♂. *Perianthium* incompletum, e squamis 2–3 subulatis inæqualibus infra medium columnæ antheriferæ insertis. *Antheræ* 3–5, longissimè lineares, in columnam conico-fusiformem elongatam solidam coadunatæ, 12–20?-loculares, loculis linearibus, extrorsis. Fl. ♀ lineares. *Perianthium* superum, tubulosum, inæqualiter 3–5-dentatum. *Ovarium* lineare, perianthio æquilongum imâ basi ovuliferum. *Stylus* cylindricus, filiformis, perianthio duplò longior, supra medium papillosus stigmatiferus. *Ovulum* 1, pendulum. *Achænia* receptaculo spongioso immersa.—Rhizoma *repens ramosum.* Pedunculi *erecti,* 1–6 *unciales, basi nudi,* squamis *coccineis circa inflorescentiam elongatis tecti, inter squamas pubescentes.* Squamæ *densè imbricatæ, latè ovato-acuminatæ, inferiores* $\frac{1}{4}$ *unc., superiores* $\frac{1}{2}$–1 *unc. longæ.* Receptaculum *spongiosum latè conicum v. hemisphæricum, convexum, floribus obtectum squamisque omninò velatum.* Fila articulata *nulla.* Flores *rubri.*

1. Thonningia sanguinea, Vahl! (Act. Soc. Hist. Nat. Hafn. vi. p. 124. t. 6, 1818). Schumacher et Thonning, Dansk. Selsk. Skrivt. vi. p. 124. t. 6. Liebmann in Proceedings of Assembly of Scandinavian Naturalists at Christiania, 1844, p. 177.

Conophyta purpurea, Isert, Reise nach Guinea, p. 283.
Hab. Guinea ad Aquapim, *Thonning*. Abeokuta, *Beat. Dom. Irving* (*fid. Ic. Pict.*).

I am indebted to Prof. Liebmann of Copenhagen for the opportunity of describing this rare plant; he having forwarded to me the original specimens from Vahl's and Schumacher's herbaria, which are deposited in the museum at Copenhagen. In his paper read before the Association of Scandinavian Naturalists at Christiania in 1844, M. Liebmann discusses the propriety of restoring Vahl's name of *Thonningia* to the American *Langsdorffiæ* of Martius and others, under the impression that they are all congeneric. As his information is very curious, and as I am obliged to dissent from his conclusions, I shall give the substance of his communication here, the paper being little likely to become generally accessible in England.

Thonningia was brought to Europe by Thonning in 1804, and described, and named after its discoverer by Vahl in the same year, in a paper read before the Natural History Society of Copenhagen, and accompanied by a plate. Whether the paper was printed does not appear; but Vahl died in 1804, and the Society was dissolved immediately afterwards. The volume, of which Vahl's paper formed a part, was not completed till 1810, when a few copies were distributed, and the rest retained by Prof. Viborg, on account of an obnoxious preface by M. Ratke, detailing a controversy between Professors Viborg and Vahl, and which was suppressed on the ultimate publication of the volume in 1818.

During the same year (1818) Von Martius published the Brazilian *Langsdorffia* in Eschwege's Journal; and the question brought forward by Liebmann is: supposing it to be congeneric with *Thonningia*, which name should be retained? Prof. Liebmann advocates Vahl's, on the ground of priority, and because his plate enables the genus to be identified, though he considers his description to be faulty*. As far as priority of publication is concerned, the claims of the names are on a par; but it appears to me impossible to include the Brazilian plants in the same genus with the African, on account of the great differences between their male flowers.

My description of *Thonningia* is drawn up from Vahl's and Schumacher's specimens and drawings. The male flower consists of a very long spindle-shaped synema, curved at the base, broadest in the middle, and tapering to a sharp point: a little below the middle it bears two or three subulate narrow fleshy scales, which are the rudiments of a perianth that is never further developed. The upper half appears from Vahl's drawing to be covered with pollen; and according to his specimens this is perfectly correct, and further agrees with Schumacher's description. In Schumacher's specimens I find no traces of anthers or pollen. In Vahl's specimens, however, I find four or five vascular bundles, and as many very long linear connate anthers, each 4-valved, bursting longitudinally, and containing globose hyaline pollen-grains with transparent borders.

The female flower of *Thonningia* only differs from that of *Langsdorffia* in a more complete tubular 3–5-toothed perianth. The parenchyma of this organ is much inflated, and is formed of very lax cellular tissue, traversed by four to six remarkable nerves. These consist

* Prof. Liebmann says that Vahl must have been in error in describing both male and female flowers, as from the plate accompanying his paper it appears that he had only female specimens: but Vahl is here right, for he certainly figures both the male plant and its flowers, t. 6. figs. *a, b, c, d*; and though not very intelligible, they are accurate, and accord perfectly with the description of Schumacher and Thonning, whose specimens Vahl examined, and which I have also examined and described here.

of one or two rigid, stout, cylindrical, yellow tubes of sclerogen, with blunt apices; their walls are transparent, but extremely thick, and they are sometimes solid in places; they entirely resemble the woody tissue commonly developed in other parts of *Langsdorffia* and *Helosis*. The style is very long, filiform, and continuously papillose along the exserted portion. I have not seen the seeds, which occupy a very minute cavity in the base of the columnar ovary, and are said to be sunk in the receptacle. The latter expands considerably after flowering, when the scales fall away from the flowering branch, and the latter turns black, and probably decays.

I know nothing of the parasitism of *Thonningia*; the rhizome is brown, slender, smooth, and sparingly branched, and rises into an obscure cup round the base of the peduncle, which is clothed with bright red scales. I find no hairs upon the rhizome, as is the case with *Langsdorffia*, but there are small woolly tufts at the bases of the leaves, on the stem. The hairs are simple, long, inarticulate, flexuose, broad at the very base, rough on the surface, and with a very large continuous cavity.

VI. Balanophora, Forst.

1. Balanophora involucrata (*supra*, p. 30).

Var. *α. rubra*, pedunculis et capitulis rubris, capitulis ovoideis bisexualibus (Tab. IV., V. & VI.).

Var. *β. flava*, pedunculis et capitulis stramineis v. flavis, capitulis unisexualibus rariùs bisexualibus.

Var. *γ. gracilis*, pedunculis elongatis gracilibus capitulisque flavis, capitulis unisexualibus parvis (Tab. VII. A.).

Var. *δ. Cathcartii*, pedunculis robustis capitulisque albis roseisve, capitulis unisexualibus (Tab. VII. B.).

Hab. In Himalayæ temperatæ sylvis humidis; Sikkim, alt. 7–9000 ped. (*J. D. H.*) Simla, alt. 6000 ped. (*Thomson*) (fl. Jul.).

Rhizoma 2–6 unc. latum, pustulis parvis cellulosis asperum, variè lobatum, nodos 3–4 poll. diam. radicibus *Aceris* et *Quercûs* efficiens. *Pedunculi* graciles v. crassi, breves v. elongati, medio involucrati, interdùm compressi v. fasciati. *Capitulum* ovoideum v. globosum, rariùs depresso-globosum; ♂ profunde alveolatum. *Flores* ♂ 2–5-meri, plerumque 3-meri. *Antheræ* tot quot lobi perianthii synemate brevi sessiles, transversè oblongæ, supernè rimâ transversâ dehiscentes. *Fl.* ♀ capitulo sessiles v. circa basin bracteolæ clavatæ aggregati.

The extreme varieties which I have here included under one species are so very dissimilar, that no one who had not seen large suites of specimens, presenting every intermediate form between them, could venture to unite them under one: as it is, I found that neither colour, form, nor the sexuality of the capitula are constant characters. In the same woods wherein I gathered the var. *gracilis* growing upon roots of oak, I also gathered var. *flava* growing on those of an *Araliaceous* shrub, and differing from the var. *gracilis* only in its more robust habit. In general there is a greater tendency in the female capitula to bear male flowers than in the males to produce female; for though I often met with female capitula bearing male flowers at their base, and sometimes at their summit, and occupying a considerable portion of the surface, I never found male capitula to bear any but very rudimentary female flowers scattered along the edges of the alveoli in which the lower part of the male perianth is sunk.

The present is the most alpine species of the genus known to me, and is common in Sikkim at 8000 to 10,000 feet elevation. I have found it on the exposed aërial rootlets of oaks in very humid forests, but, like the rest of the species, it generally grows at the foot of the trees immersed in the spongy soil. It causes large knots 2–4 inches in diameter to form on the roots of oaks and maples, and these are much sought by the natives for the manufacture of the wooden cups in general use throughout the Himalaya and Tibet.

2. Balanophora dioica, Brown in Wall. Cat. 7246; Linn. Trans. xiii. 207 in note. Royle, Ill. Plant. Himal. p. 330. t. 99 or 78 *a*. Schott & Endl. Melet. p. 13 (sub *B. elongata*, Bl.).

B. typhina, Wall. Cat. 7248.

B. picta, *B. alveolata*, *B. Burmanica* et *B. affinis*, Griff. in Linn. Trans. xx. pp. 94, 95. t. 3, 4, 5 & 6.

Variat insigniter rhizomate plùs minùsve lobato v. ramoso, lobis crebrè v. laxè pustulatis, pustulis simplicibus stellatim lobulatisve, pedunculis brevibus elongatisve, flavis albis rubrisve, squamis arctè v. laxè imbricatis, capitulis omninò unisexualibus v. fœmineis basi androgynis, cylindricis ovoideis conoideisve, columnâ stamineâ brevi v. elongatâ, antheris 3–5 arctè v. laxè compactis, floribus ♀ brevè v. longè pedicellatis, capitulo v. pedicello bracteolæ clavatæ insertis.

Hab. In Himalayæ orientalis, centralis et mont. Khasiæ sylvis subtropicis vulgatissima, alt. 3–7000 ped. (*T. Thomson et J. D. H.*); Nepal (*Wallich*); Birma (*Wallich et Griffith*); Mont. Mishmee (*Griffith*!). Fl. Aug.–Decembr. (v.v.)

This is an extremely common species in the Eastern Himalaya and Khasia, and so variable, that I am quite unable to define its varieties. Specimens of all sizes may be found, from an inch to a foot high, of all degrees of robustness, and of all colours between blood-red, yellow and white, or brown. Though usually strictly diœcious, I have found capitula bearing only male flowers on female plants, and more frequently male flowers towards the base of the female capitula. Schott and Endlicher, and latterly Junghuhn, have united this species with Blume's *B. elongata*, and I should not be at all surprised that they proved the same; but I have never found the Indian to have the long branching rhizomes of the Javanese species, and there is much less wax in the plant.

B. dioica grows indifferently on the roots of many species of shrubs and trees, but I have never found that it produces knots on these, as *B. involucrata* does.

3. Balanophora elongata, Blume, En. Pl. Jav. i. 87; Schott & Endl. Melet. 13; Unger, Ueb. d. Paras. pp. 26 & 33. t. 2. f. 1, 2; Junghuhn in Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. 207. t. 1.

Cynopsole elongata, Endl. Gen. Pl. 74.

Var. *maxima*. *B. maxima*, Jungh. in Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. 209. t. 1.

Hab. Montibus Javæ alt. 5–9000 ped. (*Blume, Junghuhn, Lobb*). Fl. Mart., Maio et August. Montibus Peninsulæ Indiæ orientalis (*Wight*) et Ceyloniæ? (*Gardner, Thwaites*).

I have, under *B. dioica*, stated what seem to me the only differences between this species and *B. dioica*, and these are rather modified in the Peninsular specimens figured by Dr. Wight in a drawing he has had the goodness to give me, and in the Ceylon specimens.

Junghuhn's *B. maxima* seems to differ only in size from *B. elongata*, the difference between these two forms being exactly analogous to that between *B. dioica* and *B. typhina*, Wall. (*picta*, Griff.).

This species produces wax in great abundance which is used for making candles in Java.

4. Balanophora Indica, Wall. Cat. 7247; Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 167. t. 9. f. 11–22.

Cynomorium, Herb. Wight.
Langsdorffia Indica, Arnott in Hook. Ic. Plant. t. 205, 206, et in Ann. Nat. Hist. ii. 36.
Hab. In montibus Peninsulæ Indiæ orientalis (*Wight, Gardner*) et Ceyloniæ (*Gardner, Thwaites*).

This much resembles a large state of *B. globosa*, differing chiefly in the longer peduncles of the female capitula, which also have many more scales.

5. Balanophora globosa, Junghuhn, Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. p. 210. t. 2.

Bal. gigantea, Wall. Cat. 7249, nov. gen. *Sarcocordylis* (fid. Bennett in Linn. Soc. Trans. xx. p. 94, in note).
Hab. Sylvis montosis Javæ alt. 3–5000 ped. (*Junghuhn, Lobb*). Birma (*Wallich*). Fl. April.

Junghuhn makes a very curious observation, that when growing with *B. elongata* (on the same root) he found this species to have the lobed pustules on its rhizome which distinguish that species, but not when it was solitary.

According to Wallich, this species is sold for medicinal purposes in the bazars of Burma.

6. Balanophora fungosa, Forster, Gen. t. 50; Richard, Elem. de Bot. (1833) t. xv. (Tab. VIII.)

Cynomorium australe, Willd. Sp. Pl. v. 177.
Hab. Insulâ Tanna Novæ Hebrides ad radices *Paritii tiliacei* (*Forster, Hinds*): ad "Goold Island" in Sinu Rockingham, orâ orientali Novæ Hollandiæ, fruticetis densissimis (*M'Gillivray*). Fl. Mai.

All the specimens of this plant which I have examined have bisexual capitula with the female flowers at the base. The surface of the rhizome is minutely granular, and not pustular; the peduncles short, stout and leafy. The male flowers have 4–5-lobed perianths, the lobes grooved inside from pressure against the anther-lobes in the bud.

I am not aware upon what plant the Australian specimens were found, but the root is very woody, as thick as a crow-quill, and consists of wood and bark with no pith, but obscure medullary rays. The wood-fibres are slender and intermixed with large cylindrical ducts and long hexagonal cells whose walls are marked with numerous short transverse bars. The vascular bundles in the rhizome are large and stout, branch in the usual manner from the root radiating outwards to the lobes of the rhizome, and consist (as in *B. involucrata*) of a thick cylinder of soft colourless parenchyma distinguished from that surrounding it by the absence of chlorophyll or wax, and in this respect resembling the bark of the root; its cells are also smaller than the other cells of the rhizome, and have rather more numerous punctuations on their walls. The individual wood-bundles form a more or less complete zone of wedges, separated by masses of the surrounding parenchyma, which also forms a broad cylinder of pith in the interior. The wood-wedges are traversed by large ducts, quite similar to those of the root; these are most abundant near the root, and become smaller and inconspicuous at a distance from it, and towards the extremity of the bundles are found as elongated hexagonal cells with barred walls.

The most curious point in the above is the tendency of the tissues forming each vascular bundle in the rhizome to arrange themselves rudely into the form of an exogenous stem, the wood forming a zone of wedges round a central pith (Tab. VIII. fig. 11) enclosed by a cellular zone that communicates with the pith by broad medullary rays: the total absence of pith in the root, with whose wood these bundles communicate, would thus seem to indicate that the wood of the rhizome belongs to itself, though it has all the appearance of being solely produced by the root; the root, in short, supplies the nutriment from its own vascular tissue, but the parasite organizes it.

7. Balanophora alutacea, Junghuhn in Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. 205; Goeppert, ibid. p. 230. t. 3. An *B. abbreviata*, Blume, En. Pl. Jav. i. 87?

Hab. Sylvis tropicis Javæ (*Junghuhn*). Ins. Philippinis (*Cuming*). Fl. Aprili.

A very much smaller species than any of the preceding, according to Junghuhn's description and plate, but probably, like its congeners, extremely variable in size. Its prominent characters are the tuberous rhizome, like that of *B. dioica* and *B. involucrata*; its few, short, broad, subvaginate scales in the peduncle, and its cylindrical capitula with a few male flowers at the base, in which character it resembles *B. fungosa* and certain states of *B. involucrata.*

8. Balanophora (Polyplethia) polyandra, Griff. in Linn. Soc. Trans. xx. p. 94. t. 7.

Hab. Sylvis subtropicis Mont. Khasiæ (*Griffith*) et Himalayæ provinciâ Sikkim, alt. 4-6000 ped. (*J. D. H.*). Fl. August.-Novemb. (v.v.)

This species is very abundant in the localities enumerated above, and varies in height (from 2 to 6 inches), in robustness, in colour, and in the form of the capitula, which are however always short and subcylindric or conical. I have frequently not been able to distinguish female specimens of this from those of *B. dioica*, nor indeed, except by the alternate scales, from those of *B. involucrata.* The numerous anthers of the male flower and usually larger perianth of that sex distinguish it from its congeners.

I have made many detailed analyses of the anatomy of this species at all stages of growth (except the germinating), both in the Khasia Mountains and Himalaya, but do not find any point of importance except the anthers in which it differs from *B. dioica*, *fungosa* and *involucrata.* The male flowers are well figured and described by Griffith.

VII. Lophophytum, Schott & Endl.

In habit this genus approaches to *Cynomorium* more nearly than to any other of the Order, as may be seen by comparing their very young states; in each the upper part of the rhizome is clothed with spirally arranged imbricating scales, which pass into the bracteal scales of the inflorescence. In both the flowers are aggregated into definite masses, which masses are immediately covered by the dependent portion of the peltate bracteal scales; but whereas in *Cynomorium* any further tendency to a branched inflorescence is arrested at a very early stage, in *Lophophytum* the development of the branches proceeds with that of the whole plant. The paleæ observed by Weddell amongst the female flowers of *L. mirabile* are a further point of resemblance, as are the irregular disposition of the vascular bundles in the rhizome and great abundance of starch-granules in the parenchyma.

It is a remarkable fact that impregnation appears to be effected in this genus when the greater part of the inflorescence is completely clothed with the imbricating bracteæ, and in some cases when the plant is still under the surface of the soil. Thus, Weddell's drawings of *L. Bolivianum* show that even after the fruit is mature it is wholly subterranean, the upper part of the male portion of the inflorescence alone being above ground. In my specimens of *L. Weddellii*, which have all the appearance of being subterranean, and which are very young, the pollen is partially shed and the fruit fully formed (though abortive), and yet the peduncle would have to lengthen to three times its present length before the scales fall away and the plant appears to be in perfection. With regard to Weddell's drawings and specimens, they suggest the idea that the upper or male part of the spike in elongating under ground sheds so much pollen in the soil, that the female capitula on the lower part of the spike, which are afterwards carried up through the same soil, are impregnated by the pollen-grains remaining imbedded in it. On the other hand, *L. Weddellii* being diœcious, suggests insect-agency as absolutely essential to the process.

I have already (p. 24) alluded to the remarkable similarity between the inflorescence and flower of this genus and of *Gunnera*.

1. Lophophytum mirabile, Schott & Endl. Melet. i. t. 1; Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 185. t. 10. f. 31–33.

Archimedea, Leandro.

Hab. Sylvis tropicis Brasiliæ meridionalis prov. Sebastianopol (*Schott*): *Leandro* (in Hb. Mus. Paris.).

This very remarkable plant is well figured by Endlicher, who however represents it in a very advanced state, when the peltate scales have fallen away from the base of the capitula of flowers; the younger specimens preserved in the Paris Herbarium altogether resemble those of *L. Weddellii*, but are much smaller. According to a drawing of M. Weddell's, apparently of this species (and which was copied from one by M. Descourtils), the whole plant appears immersed in the soil with the exception of the inflorescence, which rises up like the upper part of a long pine-cone with sharp erect brown scales that conceal the red male flowers.

The scales observed and figured by Weddell amongst the female flowers much resemble those of *Cynomorium*; they are apparently bracteolæ, subtending the female flowers, to which they are very obscurely attached.

2. Lophophytum Bolivianum, Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 185. t. 10. f. 29, 30.

Hab. In Boliviæ prov. de Cordillera, sylvis humidis. Fl. Novembri (*Weddell*).

I am indebted to Dr. Weddell for a fine drawing of this species and for specimens. In general appearance it closely resembles *L. mirabile*; but the rhizome is lobed, the lobes rounded, and it appears to be buried up to far beyond the middle of the inflorescence in the soil, the whole of the female flowers and the lower half of the male or upper portion of the spike being subterranean: as however the *Balanophoræ* and *Rhopalocnemis* are sometimes wholly exposed (even the rhizome), and at others almost immersed in mould, so may these plants be; to which it may be added, that in the tropical forests wherein these plants grow, sudden accessions of rain may often alter the relative level of a plant and the soil in which it grows.

M. Weddell remarks the absence of styles in this species as constant; but all his specimens being advanced, and these organs being extremely caducous, I am not disposed to lay much stress upon the fact of none of the specimens presenting them. The form of the fruit differs from that of *L. mirabile*, being much less contracted at the base. This however is a variable character, and I am inclined to agree with M. Weddell in suspecting the possibility of its being only a variety of the Brazilian species.

The arrangement of the stamina upon the lobes or mamillæ of the peduncle appears to be definite, though at first sight they appear irregularly clustered. M. Weddell's figure and specimens show that the whole surface of each mamilla is covered with lobed conical masses, which are connate male flowers, each consisting of two mamillæ placed right and left to the axis, and two stamens, one opposite each mamilla.

3. Lophophytum Weddellii, nob. (*supra*, p. 30). (Tab. IX.)

Hab. In sylvis humidis montium prov. Ocaniæ, alt. 3–4000 ped., Novæ Granadæ (*Purdie*). (*Nom. vern.* "Cardon de la Cordillera.")

I have very fine specimens of this plant sent by Mr. Purdie, but all in a young state, with the peduncle wholly covered by the imbricating peltate bracts; but the stamens and pollen fully developed, the anther-cells dehisced, and the fruit, though empty, fully formed, and its walls crustaceous or bony. It differs from *L. mirabile* in the much larger size, and in being apparently invariably diœcious: I find no paleæ amongst the female flowers.

The root upon which my specimens grew is as thick as the wrist; it is of considerable age, is not much swollen at the surface of contact, has no pith or annual rings, but very evident medullary rays. The rhizome of the largest specimens is sunk $\frac{1}{2}$–1 inch in a shallow obconical cup in the root. I find no traces of vascular bundles uniting those of the rhizome and the root.

The tissue of the rhizome consists of a very dense cortical layer of crustaceous sclerogen-cells, which sometimes separates like a bark and encloses a loose cellular mass full of starch-granules and vascular bundles traversing the whole in sinuous courses. The vascular bundles consist of fusiform ducts and tubes with barred or ringed cylindrical or angular walls, surrounded by a laxer tissue of more elongated cells. The arrangement of the peltate scales on the peduncle, and their position relatively to the masses of the flowers in the bud, are exactly as in *Cynomorium*; the lower or dependent portion of each bract immediately covers the mamilla of flowers below it, its upper or ascending portion covering the dependent base of the scale above it. The vascular bundle of each mamilla of flowers does not, however, unite with that of the bract above it, but with that below it.

VIII. Ombrophytum, Pœpp. & Endl.

This genus bears the same relation to *Lophophytum* that *Balanophora* does to *Cynomorium*, inasmuch as the flowers, instead of being inserted upon the capitulum, are whorled round the pedicel of the bract. In the structure of its female flower it hardly differs from *Lophophytum*; the male flowers, according to Weddell's drawing, appear to consist of a solitary stamen with no trace of a perianth.

The figure given in Pœppig and Endlicher's 'Nov. Gen. et Sp. Plant.' is probably made up in part from notes or memory, for it can hardly be doubted that the plant they intended is specifically the same as Weddell's *O. zamioides*, as he himself informs me. The rhizome is solitary, tuberous, not lobed, and bears one peduncle, which is surrounded at the base by a large volva. The inflorescence is cylindrical, and there is no interruption between the male flowers which occupy the upper half of the peduncle and the females. The bracts are quite similar in each, are persistent, and have a broad orbicular peltate disc.

1. Ombrophytum peruvianum, Pœpp. & Endl. Nov. Gen. et Sp. Plant. ii. p. 60. t. 155.

O. zamioides, Weddell, in Ann. Sc. Nat. sér. 3. xiv. t. 10. f. 23–28.

Hab. In sylvis densis Peruviæ subandinæ ad Cuchero (*Pœppig*); et prov. de las Cordilleras (*Weddell*). Fl. Sept.–Nov. (*Nom. vern.* "Mays del Monte," *Pœpp.*)

IX. Scybalium, Schott & Endl.

1. Scybalium fungiforme, Schott & Endl. Melet. p. 3. t. 2. Unger in Ann. Wien. Mus. ii. t. 2. f. 4, t. 4. f. 19, 20.

Hab. In sylvis Brasiliæ ad Sierra d'Estrella (*Schott*).

I have nothing to add to the excellent description cited above. In habit the genus approaches *Langsdorffia* more than any of the *Distyli*. In the crowded and often connate peduncles and unisexual capitula, as well as in the plane figure of the latter, it differs from its allies; also in the filiform hairs which occur amongst the male flowers and are exserted far beyond the articulated threads, and which are probably undeveloped females. The 2-celled ovary invariably (as it is described) followed by a one-seeded fruit, is unique in the Order.

The rhizome resembles that of *Corynæa*, the scaly peduncle that of *Sphærorhizon*. The fact of one male peduncle being always surrounded by several females on the same rhizome is unique, and does not necessitate the operation of dichogamy which occurs in *Helosis*. From fig. 13 of the plate quoted, it appears that the male flowers are developed in succession for a considerable period.

X. Sphærorhizon, Hook. fil.

Rhizoma napiforme seu depresso-globosum, solitarium. *Pedunculus* solitarius, curvus, squamatus, basi annulo brevi rhizomatis circumdatus, junior squamis densissimè imbricatis velatus, demùm elongatus, squamis oblongis obtusis subpeltatis denique deciduis. *Capitulum* ovoideum, monoicum, squamis deciduis peltatis tectum. *Flores* et fila articulata *Helosis*, sed synemate 3-loculari apice dehiscente.

1. Sphærorhizon curvatum, Hook. fil. (Tab. X.)

Hab. Sylvis alpinis Novæ Granadæ inter vicum Niva et montes Paramo de Ruiz dictis (*Purdie*). Fl. Jul.

Rhizoma $\frac{3}{4}$–3 unc. diametr., obscurè lobatum, radicibus validis sessile. *Pedunculus* flexuosus 1–6 uncialis, validus, $\frac{1}{2}$ unc. diametr., interdùm brevissimus et squamis multiseriatis patentibus densissimè imbricatis tectus, interdùm elongatus squamis longioribus $\frac{3}{4}$ unc. longis obtusis latâ basi subpeltatim affixis laxè velatus, squamæ infra capitulum magis peltatæ latè adnatæ basibus apicibusque truncatis sub-recurvis. *Capitula* latè oblongo-cylindracea v. ovoidea, filis articulatis densissimè operta, e squamis delapsis areolata. *Flores* masculi synemate solido triloculari (nempe antheris unilocularibus) cylindraceo, apice dehiscente, septis e strato duplici conflatis, exteriore celluloso, interiore floccoso albido e fibris minutissimis implexis. *Pollen* globosum, immaturum 3-nucleatum, maturum peripheriâ hyalinâ, tuberculis 3 notatâ. *Ovarium* lineari-obovatum compressum, perianthii labiis latè ovatis, stylis breviusculis recurvis. Fila articulata lineari-clavata simplicia v. variè coadunata.

A very curious and peculiar-looking plant, of which Mr. Purdie has sent several specimens belonging possibly to two species, and differing remarkably in the amount and disposition of the scales of the peduncle. These in small short specimens form a dense mass between the rhizome and capitulum, are very numerous, closely packed, broad, short and patent: in specimens 3–5 inches long, the scales are more loosely placed, linear-oblong, adnate by a broad base, and those towards the capitulum are completely peltate or sessile by the middle and lower part of the face of the scale; the upper parts and base being truncate, free, and slightly recurved: still larger and apparently old specimens appear to have shed these scales altogether. The bracts on the capitula are much larger than in *Helosis*, but are in an imperfect state upon the only specimen retaining them.

The plants are evidently of annual duration, penetrating the last year's wood only, and producing no injury in the layers below that.

XI. Phyllocoryne, Hook. fil.

Rhizoma crassum, deforme, ramosum. *Pedunculi* crassi squamis hexastichè imbricatis tecti, supernè tuberculis conicis densissimè obsiti. *Capitula* androgyna, cylindracea, squamis imbricatis deciduis tecta: filis articulatis densissimè operta. Fl. ♂. *Perianthium* 3-lobum. *Antheræ* 3 in capitulum 6-loculare apice dehiscens connatæ. Fl. ♀. *Ovarium* obovatum, compressum, calycis limbo bilabiato coronatum. *Fructus* turgidus, utrinque truncatus.

1. Phyllocoryne Jamaicensis. (Tab. XI.)

Cynomorium Jamaicense, Swartz, Fl. Ind. Occ. i. p. 11; Browne, Jam. p. 334.
Helosis Jamaicensis, A. Richard, Mém. Mus. viii. 432.
Scybàlium? *Jamaicense*, Schott & Endl. Melet. p. 12.
Hab. In sylvis savannisque Jamaicæ (*Swartz, Purdie, Wilson*). Fl. Jan.–Jul. (*Nom. vern.* "John Crow's nose.")

Richard suggested the separation of this from *Helosis*, with which genus however it entirely agrees in the structure of the flowers of both sexes, but differs remarkably in habit, in the leafy peduncles, and imbricated bracts of the capitulum. Like its congeners, it varies extremely in stature and in the relative size of its organs; old specimens form subterranean masses a foot in diameter.

The rhizome on a transverse section presents a thick, brown, cellular cortical layer, formed of hexagonal cells full of starch-granules and chlorophyll, with occasionally masses of sclerogen-cells. The axis is occupied by a slender column of cellular tissue forming a true pith; it is surrounded by a layer of long woody sclerogen-cells or tubes that pass between the wood-wedges as medullary rays, and are there shorter and cubical. The wood-wedges are about twenty, lanceolate (on the transverse section), symmetrically disposed round the axis, and are composed of pale slender tubes, which are scalariform or subspirally marked. Outside of each wedge is a bundle of liber-cells, which are long sclerogen-tubes. This arrangement accords with that of *Helosis*, and is essentially exogenous.

The young peduncle and capitulum are wholly concealed by the imbricating scales and bracts, which are hexastichously arranged in my specimens, but pentastichously as described by Swartz. As the peduncle elongates the bracts fall away from the lower part of the capitulum, leaving an areolated surface; the uppermost are persistent for a considerable period. The upper part of the peduncle or base of the capitulum is rough with conical papillæ, which become fusiform and slenderer upwards as they mix with the articulated threads and female flowers, of which they appear to be arrested states.

The female flowers protrude their styles, which are bent down under the bracts, as soon as the latter fall away, and the evolution of the flowers follows the same law as in *Helosis*. The ovary resembles that of *Scybalium* more than of *Helosis*, being broader, with larger semicircular lips to the calyx and short stout diverging styles. The fruit is broadly ovoid, truncate at both ends, striate, sulcate towards the apex, and more turgid than usual amongst the *Helosideæ*. On a transverse section the style is found to consist of about eight large cells surrounding a few smaller ones that enclose a soft conducting tissue. The seed is broadly oblong, compressed, very oily, of the same structure as *Helosis*.

The articulated threads of the capitulum are (like the ovaries) much broader in this genus than in its allies, and are often fusiform and geminate. The apical cells turn black, and their cell-walls become minutely wrinkled soon after the bracts fall away.

The male flowers have often a 4-lobed perianth, and the odd lobe is as often the lower as the upper; there being no constant arrangement of the lobes with reference to the axis of the capitulum. The anthers are 2-celled, narrow oblong, and the pollen escapes through an irregular opening at the apices of the loculi: the filaments are free just below the insertion of the anthers. Pollen globose, with four minute papillæ on the surface.

XII. Rhopalocnemis, Junghuhn.

Char. emend.—*Rhizoma* deforme, globosum, lobatum. *Pedunculi* basi volvâ carnosâ irregulariter fissâ circumdati. *Capitula* elongata, bracteis peltatis deciduis velata, unisexualia, filis articulatis densè obtecta. Fl. ♂. *Perianthium* campanulatum, integrum, basi columnæ stamineæ adnatum. *Filamenta* coadunata, longè exserta; antheræ 3, 2–4-loculares, arctè cohærentes, apice debiscentes. Fl. ♀ oblongæ, compressæ; perianthio bilabiato; stylis 2 elongatis; ovulo 1 pendulo. *Fructus* lineari- v. ovato-oblongus, turgidus. *Semen Heloseos.*

1. Rhopalocnemis phalloides, Junghuhn, in Nov. Act. Acad. Cæs. Nat. Cur. vol. xviii. Suppl. p. 215. (Tab. XII.)

Phæocordylis areolata, Griff. in Linn. Soc. Trans. xx. p. 100. t. 8, descript. incompleta.

Hab. Sylvis *Acaciæ* montibus Ins. Javæ, alt. 7000 ped. (*Junghuhn*)! Sylvis densis montium Khasiæ, et Himalayæ orientalis, Nepaliæ orientalis et Sikkim, alt. 6–8000 ped. (*Griffith, Thomson, J. D. H.*). Fl. Jul.–Sept.

This most remarkable plant has been much misunderstood, both by the author of the genus, M. Junghuhn, and more recently by Griffith. From Junghuhn's description it is probable that his specimens were most imperfect, and perhaps covered with mould. The museum at Kew is indebted to Prof. de Vriese of Leyden for beautiful Javanese specimens of both sexes, which being authentically named, enabled me to recognize Junghuhn's plant as identical with the Himalayan and Khasian one; and which, making allowance for the absence of male flowers, and for his erroneous description of the females, is also identical with the *Phæocordylis* of Griffith, gathered at the same spot in the Khasia Mountains where Dr. Thomson and I procured an abundant supply of specimens.

Rhopalocnemis is by far the largest and the handsomest of the *Helosideæ*, and it is the only one which I have had an opportunity of examining in a living state; it is most closely allied to *Corynæa*, differing in the presence of a volva and in the unisexual capitula. It grows gregariously, in shady mountain woods, its large heads of a pale yellow-brown colour alone appearing above ground: it is of a firm, fleshy consistence, perfectly inodorous even when decaying. I have vainly tried to induce the ripe seeds to germinate, and have examined many hundreds in the fruitless attempt to discover any embryo in the mass filling the whole cavity of the seed. During the shedding of the fruit, the capitula (of gathered specimens) copiously exuded a transparent sugary fluid, but I have never observed this on the living plant: it is no doubt analogous to the fluid described by Weddell as bathing the capitula of some *Balanophoreæ*, and supposed by that author to be of use in the operation of fecundation.

The rhizome varies from the size of an egg to that of the human head, and is supplied internally with many stout woody branches, which appear continuous with the wood of the rootstock, and which upon maceration are found to send continuous bundles to the top of the capitulum. The peduncles are solitary, or many together on large rhizomes, and are enveloped at the base by a hard, fleshy, erect, cylindrical volva, $\frac{1}{2}$–2 inches high; they vary in length from 2 to 6 inches, and in diameter from $\frac{1}{2}$ to 2 inches; they are altogether naked below, but in the upper part are covered to a greater or less distance below the capitulum with fleshy, patent, and somewhat recurved scales, $\frac{1}{4}$ inch long, which appear to be persistent, and to occur chiefly on the male plants. The hexagonal fleshy scales which cover the whole capitulum are altogether similar to those of *Helosis*; as are the female perianths to those of *Corynæa*, and the males to those of *Helosis*.

In flowering, both males and females expand at the same time, throwing off their cohering bracteal scales in large masses, and exposing a velvety pile of styles, and a dense mass of subjacent articulate threads. There are several crops of male flowers, which expand successively; and in the dense humid calm woods in which this genus grows, insect agency is probably necessary to impregnation. During the ripening of the fruit, the surface of the capitulum becomes areolated from the swelling of the masses answering to an obscure lobing of that organ, and at first externally defined by one of the fallen bract-scales, and internally by a vascular bundle from the plexus of vessels within the capitulum.

My examination of living specimens, both in the Khasia Mountains and in Sikkim, led to no results which may not as well be obtained from those preserved in spirits, for the sphacelation and browning of the cut surfaces were so instantaneous, that I had to put the sections in spirits as soon as made. A careful study of the ovule and seed at all stages of growth led to the same conclusions as were obtained from *Balanophora involucrata*. After flowering, the capitulum and peduncle wither, dry, and fall away from the base of the volva, but do not deliquesce nor turn putrid, nor are they attacked by insects to any extent. Each peduncle seems to become detached from the rhizome by a very obscure articulation, which may be seen as a dark transverse line, on a longitudinal section of the base of the peduncle, some time before its falling away. The rhizome is perennial, but does not give forth its buds until July, and the plant ripens its fruit in September.

The apex of the stigma, described and figured by Griffith as an opaque rounded body, is when young, and even after impregnation, perfectly simple.

The apices of the articulated hairs consist of several series of cells, which are (as figured by Griffith) much darker than the rest; and the outer cell-membrane becomes transversely wrinkled, as in the South American *Helosideæ*.

XIII. Corynæa, Hook. fil.

Rhizoma deforme, lobatum. *Pedunculi* nudi. *Capitula* androgyna, squamis hexagonis peltatis velata. Fl. ♂. *Perianthium* infundibuliformi-campanulatum, margine crenatum. *Antheræ* 3 v. synema 6-loculare. Fl. ♀. *Heloseos.*

1. Corynæa crassa, Hook. fil.; capitulis clavatis cylindraceis. (Tab. XIII.)

Hab. Sylvis densis *Cratægi*, *Thibaudiæ* et *Befariæ*, prope S^{ta} Fé de Bogota, Novæ Granadæ, alt. 8000 ped. (*Purdie*, 1846).

Rhizoma lobatum, a magnitudine nucis *Juglandis* ad capitis humani. *Pedunculi* plurimi, juniores basi annulo cincti, 1–8 unc. longi, $\frac{1}{2}$–$1\frac{1}{2}$ unc. crassi, nudi, cylindracei. *Capitulum* obovato-oblongum v. clavatum, in pedunculum attenuatum, flores perplurimos utriusque sexus gerens, filis articulatis immixtis. Fl. ♂ ad basin capituli plurimi. *Perianthium* basi cum tubo stamineo connatum, supernè ampliatum, filis paullò longius, margine crenatum, rariùs fissum. *Columna* staminea longè exserta, filamentis omninò coalitis. *Antheræ* 3, 2-loculares, arctè cohærentes, introrsùm et ad apices dehiscentes. *Pollen* 3-4-nucleatum. Fl. ♀. *Ovarium* obovato-oblongum, compressum, limbo perianthii breviter bilabiato coronatum; *styli* graciles, elongati. *Fructus* latè oblongus v. orbicularis, compressus.

This fine species often weighs many pounds, and is so abundant that the roots of a plant attacked by it resemble a mass of potatoes. The rhizome encloses the roots of the plant on which it grows parasitically. In the evolution of the flowers it follows the same law as *Helosis*. The male flower entirely resembles that of *Rhopalocnemis*. After the fall of the scales from the capitula, both the stigmata and the tips of the articulate threads covering the head sphacelate; the latter wrinkling, and the stigma, which consists of two series of globular cells (enclosing a mucilaginous passage down the style), becomes minutely punctulate. The body of the style consists of about eight large peripherical cells, enclosing the cellular conducting tissue. The cavity of the ovarium is small, compared with its congeners; and the seed * is also small and broad.

* In Tab. XIII. figs. 11, 12, 13, I have figured a large embryo in the axis of the seed: this I found in only two fruits (now ten years ago); but having many times since attempted in vain to find another, I withheld all allusion to it in the body of this memoir. Since Mr. Weddell has informed me of the very rare occurrence of the calyx in *Sarcophyte*, I have been induced to reconsider the propriety of introducing these drawings, and now do so with the more confidence from the embryo of *Sarcophyte* being so entirely similar to this.—Kew, Aug. 2, 1856.

At the earliest period each female flower often appears as two flagon-shaped bodies, connate from the middle downwards; and at that stage is evidently composed of two ovaria: when fully formed, and the scales are still attached to the capitulum, the styles are exserted far beyond the articulate threads, and are sharply bent down, so that the stigmata are in contact with the apices of the threads. The utricular tissue of the capitulum is composed of hexagonal cells, each containing a loose inner coat, full of starch and endochrome.

2. Corynæa sphærica (Hook. fil.); capitulo solitario globoso cavitate rhizomatis semi-immerso. (Tab. XIV.)

Hab. Sylvis montanis Novæ Granadæ, alt. 5–8000 ped. (*Purdie*).

Rhizoma deforme, lobatum, diametro 2–4 unciali, infra capitulum in cupulam hemisphæricam marginibus crassis obscurè lobatis ampliatum. *Pedunculus* brevis, crassus, nudus. *Capitulum* exactè globosum, 2 unc. diametr., squamis peltatis hexagonis velatum. *Flores* masculi ut in *C. crasso,* sed perianthio breviore latiùs campanulato truncato obscurè trilobo.

A very different species from *C. crassa.* The rhizome completely surrounds the root of the stock; and in a transverse section I find that the latter is sometimes so completely broken up, that the end which enters seems cut off from that which leaves the rhizome. (See Tab. XIV. fig. 14.)

3. Corynæa Purdiei (Hook. fil.); rhizomate depresso horizontali lato lobato, pedunculis brevibus crassis, capitulis oblongis globosisve.

Hab. Sylvis montosis Novæ Granadæ (*Purdie*), radicibus *Cinchonæ*: sylvis prope St. Juan del Oro, Peru (*Weddell*).

I am indebted to M. Weddell for an excellent drawing and specimen of this very distinct little species, of which I had previously received a small example from Mr. Purdie. The rhizome forms a continuous broad flattened lobed mass enveloping large roots of *Cinchona* several inches to half a foot in extent, and is about $\frac{3}{4}$ inch in average thickness. The lobes are but little elevated, and give off short white peduncles, $\frac{3}{4}$–1 inch high, that are conical below and about $\frac{1}{2}$ inch in diameter. The capitula are nearly globose or ovoid, about $1\frac{1}{2}$ inch diameter, are quite white at first, but covered with red-brown hexagonal peltate scales. The flowers entirely resemble those of *C. sphærica.*

There is sometimes a very obscure volva at the base of the peduncle.

XIV. Helosis, Rich.

(Tab. XV. & XVI.)

Caldasia, Mutis, Sem. Nov. Granad. *Lathræophila,* Leandro de Sacram.

Rhizoma horizontale, gracile, teres, ramosum, hic illic nodosum, ad nodos pedunculos (ramos floriferos) emittens. *Pedunculi* erecti, basi v. medio v. infra capitulum involucello annulari donati, rariùs omninò nudi. *Capitula* androgyna, filis articulatis operta, juniora squamis peltatis hexagonis velata. Fl. ♂. *Perianthium* tubulosum, limbi lobis 3 valvatis, tubo intùs basi rudimento ovarii conico instructo. *Synema* fauce perianthii adnatum. *Antheræ* 3, introrsæ, in massam 6–12-locularem coadunatæ. Fl. ♀ subsessiles. *Ovarium* elliptico-oblongum, utrinque obtusum, compressum, limbo perianthii breviter bilabiato coronatum, 1- (rarius 2–3) loculare. *Styli* 2, rariùs plures, filiformes. *Stigmata* subcapitata, papillosa. *Ovulum* 1, pendulum. *Fructus* subcrustaceus. *Semen* 1, achenio conforme, testâ tenuissimâ hyalinâ reticulatâ.

Helosis appears to be the commonest American genus of the Order, inhabiting both sides of the Andes, and extending from Mexico to the river la Plata. The species much resemble one another in general characters, and are of a whitish colour tinged with red, and become red-brown when dry: they are said to inhabit moist grounds, where their rhizomes spread annually by innovations to a considerable distance, seeking nourishment from various roots in their progress, and seeming to have the power of attacking such as they come in contact with. Each year's rhizome is probably annual, and it gives off an innovation before dying, as described by Richard; the whole mass sometimes perishes at once.

The parasitism is simply that of adhesion by the contact of the tissues of the *Helosis* with those of the root-stock; in the older specimens there are no vascular bundles uniting both, and the roots attacked do not swell up to any remarkable size at the point of union; though the parasite often penetrates deeply into the wood by a conical protuberance. In very young plants, however, the wood of the root-stock ramifies extensively through the tubers of the parasite. A transverse section of the rhizome shows a most distinctly exogenous structure, very curiously modified, and varying considerably in the different species, under which the details will be given which have been already referred to in the general remarks on the anatomy of the Order.

The peduncles are always erect, and rise from a swelling on the rhizome, whence they receive many vascular bundles. The bundles in the peduncle are, however, simple, and either promiscuously scattered, or arranged in a circle; each resembles in structure that of a monocotyledonous stem, having its own liber, wood, and vascular portions; but the bundles do not follow the course that they do in endogenous stems, and are not to be regarded as indicating any affinity between *Helosis* and Monocotyledons: they are, in fact, solitary bundles such as occur in the leaves, and often in the annual flowering branches of other Exogens.

An incomplete involucre, generally divided into 3–6 broadly ovate segments, is frequently present in this genus; in *H. Guyanensis* it is placed at the base of the peduncle, in the Andes variety of that species it is carried up towards the apex, while in *H. Mexicana* it is either reduced to an elevated ridge round the centre, or entirely absent. When fully developed, this involucre never encloses the young capitulum.

Hexagonal, peltate, fleshy scales cover the whole capitulum, as in the Indian *Rhopalocnemis*. In a very young state these will be found to be developed as imbricating, ascending, bracteal leaves, each covering a definite portion of the inflorescence, which is indicated by a vascular bundle, given off from a plexus in the body of the capitulum; their position is hence analogous to bracts subtending branches of a flowering axis. As the inflorescence grows, they become peltate, hexagonal from mutual pressure, and adhering by their contiguous edges, fall away in large masses, leaving corresponding areolæ faintly marked on the capitulum.

The male flowers have usually a conical body at the base of the tube of the perianth, which probably represents a rudimentary ovary. The filaments are free just below the anthers, to a greater or shorter distance, which varies in the individual species, as does the length of the filaments. The anthers burst introrsely; they are firmly united into an obtusely trigonous mass enclosing a central cavity; each is 4-celled, the mass consequently being originally 12-celled: the cells are shown in a transverse section to be disposed in two concentric series, of which the inner has much the smallest cells; generally the two rows become confluent.

The female flower offers little worthy of notice, except the occasionally 3-lobed young flowers, indicating three ovaria, as figured in TAB. XVI. figs. 8, 9, 10; and the anomalous membrane enveloping the terminal cells of the articulated threads in *H. Mexicana*, which is probably mucous, and may be the source of the fluid which is said to bathe the capitula of some species during flowering, and thus to facilitate the dispersion of the pollen.

1. HELOSIS GUYANENSIS, Rich. Mém. Mus. viii. p. 416. t. 20; Martius, Nov. Gen. et Sp. Plant. Bras. iii. p. 184, t. 300 & 208. fig. 2.

Caldasia Cayennensis, Mutis, fid. Steud.

Cynomorium Cayennense, Swartz, Fl. Ind. Occ. i. 13.

Var. *α*. pedunculo elongato gracili, volva v. involucro ad basin pedunculi.

Var. *β*. pedunculo abbreviato, volva v. involucro ad basin pedunculi. *H. Brasiliensis*, Schott & Endl. Meletem. p. 12.

Var. *γ*. *andicola*, pedunculo brevi, volva v. involucro 4–6-fido infra capitulum sito.

Hab. Sylvis humidis Guiana, *Richard*; Para, *Martius*, *Spruce* (Aug.–Dec.); Jamaica et Trinidad, *Purdie* (May 1848); Berbice, *Schomburgk*; Pampas, Buenos Ayres, *Miers*.—Var. *β*. Rio de Janeiro, *Miers*; Serra d'Estrella, Brasiliæ, *Schott*.—Var. *γ*. Vegas de Rio Quindiu, *Goudot* (in Herb. Webb, No. 140).

This remarkable plant has been well described by Swartz, and again (with illustrations) by the elder Richard, and by Von Martius. It appears to be common in damp woods, on the east coast of South America, ranging from Trinidad to south of the Equator. It varies extremely in size, being from an inch to nearly a foot in height; with slender or robust peduncles and rhizomes, and ovoid or subcylindrical capitula, which (according to a drawing by Sir Robert Schomburgk) are sometimes lobed or even deeply bifid at the summit. Schott and Endlicher have made a species of the var. *Brasiliensis*, because of its 3-lobed involucre and small size; but the involucre is generally 3-lobed, and is described as such in the Guiana species by Richard and Martius, and Miers's Brazilian specimens have 5–6-lobed involucres.

The rhizome creeps to great distances in spongy soil, forming adhesions with the roots it encounters. A transverse section of Trinidad specimens displays an arrangement of the tissues in several respects closely resembling that of many Menispermous plants.

The axis, or position of the pith, is occupied by a cylinder of elongated, hard, woody, cylindrical tubes, with very narrow, often interrupted cavities, and this sometimes surrounds a central pith of loose hexagonal cells*. These tubes become broader and shorter

* The occasional presence of a cellular pith within this woody axis is important, as it reduces the type to which *Langsdorffia* belongs, which has no cellular pith, to that of most other *Balanophoreæ*. It is a curious fact, that in many *Balanophoreæ* the relation of the vascular system to the cellular is reversed, in respect of the latter being excessively dense, hard and rigid, whilst the true woody system is composed of extremely lax, soft, thin-walled vessels,—of ducts, in fact, with little or no pleurenchyma.

between the wood-wedges, where they appear as medullary rays, lastly passing into the loose hexagonal tissue of the circumference of the rhizome.

Seven narrow, elliptical, pale white wedges succeed the woody axis that occupies the position of the pith, then radiate, are equal in length to about half the radius of the rhizome, and placed midway between the periphery and circumference; they are separated from one another by the broad medullary rays, which assume the character of cubical, hard, brittle wood-cells consolidated into one dense firm mass, protecting the softer tissue between them. The wedges themselves are formed of delicate, white, large tubes, placed end to end, and transversely marked with short lines, annular or spiral bands.

A broadly semilunar or kidney-shaped mass of wood-cells (liber) is placed externally to each vascular wedge and curves round its outer extremity, and is either placed closely in apposition to the vascular wedge, or is separated from it by a little cellular tissue. These wood-cells are very large and thick-walled, are vertically elongated, and form long parallelograms placed end to end, and adhering firmly one with another, become of a dense yellow, almost crustaceous or osseous consistence; their walls are everywhere perforated by minute canals, giving them a punctate appearance.

The cortical portion or cellular tissue of the periphery is formed of hexagonal thick-walled, almost woody cells, with perforated faces, and there are scattered irregularly through it very large sclerogen-cells and liber-bundles. This cortical portion is spongy in consistence, and its hexagonal cells gradually pass into the cubical ones of the medullary rays.

Such appears to be the arrangement in the first year; in the second, more woody liber-bundles are formed outside the semilunar ones, and alternating with them. The wedges of vascular tissue do not appear to be added-to much, but there is an appearance of incompleteness towards their circumference, as if a cambium-layer existed there. Strictly speaking there are only two well-defined kinds of tissue in the rhizome:—1. the delicate vascular wedges, and 2. the coarse, hard, hexagonal cellular tissue of the periphery, which becomes indurated between the vascular wedges and passes into the slender woody tubes of the pith: the other tissues that are so conspicuous on a transverse section are not so on a vertical one, the broad sclerogen-tubes of the semilunar bundles of liber differing little from the cubical cells surrounding them, and the liber-bundles of the periphery altogether resembling the long woody tubes of the pith.

Many deviations may be found in different specimens from the above-described arrangements of the cellular and vascular systems of the rhizome; but all, I think, may be easily reduced to this týpe.

The vascular system of the peduncle consists of scattered bundles that run free and unbranched from the rhizome to the capitulum, where they partially anastomose, forming a plexus within the circumference, from which bundles are given off with great regularity towards the base of each scale. I do not find the tissues of these bundles to be more than rudimentary; but traces of their each consisting of a bundle of woody tubes towards the axis, followed by delicate transversely barred vessels, and these again by sclerogen-tubes, may, I think, be detected.

Richard describes the styles as occasionally united at their bases, which I have never seen; he also states that he has never observed the plants to be truly parasitical, though their roots intertwine with those of other plants: my specimens undoubtedly contract broad organic adhesions with the roots they encounter, and in the young state receive woody bundles from them. Richard's admirable account of the epoch of fecundation agrees with what I have observed in the monœcious *Balanophoræ* of India. The capitula are never self-fertilized; the styles of the female flowers are protruded immediately after the fall of the scales, and fertilized by the pollen of a neighbouring capitulum; the styles then fall away, and during the maturation of the fruit, the male flowers are protruded and shed their pollen to fertilize another capitulum; by the time that the latter operation is performed the fruits have ripened, are shed, and the peduncle and capitulum perish, though the latter still contains an abundant crop of young male flowers, apparently destined never to perform their functions. This apparent superfluity of male blossom is a very remarkable phænomenon, and not at all comparable with the common one of numerous male flowers on one inflorescence never becoming perfected except under favourable conditions, for in this case there appears to be a second crop of males after the first have performed their office, and after the females of the same and all the other capitula are fertilized, and it is difficult to conceive any circumstances arising at all likely to call for the operation of these complementary males.

Martius mentions that a beetle of the family of *Curculionidæ*, or its larva, possibly assists in the fecundation, as it is found nidulating in the capitula; judging however from the fact of one capitulum being fecundated by another, the larvæ could be of little use, nor can the beetles themselves be of much, under ordinary circumstances.

Martius mentions delicate thread-like radicles as proceeding sometimes from the base of the seed (embryo): that author also states that the disposition of the vascular system, both in its nature and arrangement, is monocotyledonous, an error to which I have elsewhere alluded in my general remarks on the Order.

Schott and Endlicher (Meletem. p. 8) observe, that in their *H. Brasiliensis* there are sometimes two and even three cavities in the ovarium, accompanied in the latter case by three styles. I have never seen such an arrangement in any specimens of this species, but indications of it will be shown to occur in the lobed young flowers of *H. Mexicana.* Swartz (Fl. Ind. Occ.) describes the styles as sometimes solitary, probably from one having fallen away, as he did not examine living specimens.

In the variety γ, for which I am indebted to the late P. B. Webb, Esq., the cellular tissue of the periphery consists of vertically elongated and much more delicate utricles, often filled with starch and chlorophyll grains: there is also a slender central column of true cellular pith surrounded by those woody tubes that are often seen to be the only pith of the varieties α. and β.

2. Helosis Mexicana, Liebmann, Proceedings of the Scandinavian Meeting of Naturalists, p. 181.

H. aquatica, Mutis MSS. in Herb. Hook.

Hab. Mexico montibus ditionis Vera Cruz et Oajaca, alt. 3–5000 ped., *Liebmann* (v. ic. pict. a cl. auct.). Mirador (*Linden*), Jul. Convallibus humidis Novæ Granadæ ad Melgar (*Purdie*), Febr. 1846.

Less variable in form and more so in robust or slender habit than the preceding. The earliest stage at which I have examined this plant is that of an amorphous cellular hemispherical mass nidulating within and almost enclosed by the bark of the roots, into the wood of which it had penetrated, its cellular tissue being in immediate contact with the wood-fibres: in this early stage it contained no vascular tissue and no traces of lobing or of peduncle. When fully developed, this species so entirely resembles *H. Guyanensis* in all but the nature and position of the volva or involucre (here reduced to an oblique ring about half-way up the peduncle), as to preclude the necessity of a detailed description, and I shall proceed at once to some remarks on its structure and development.

The structure of the wood of the rhizome is essentially the same as that of the preceding species. The vascular bundles of the peduncle are, however, more regularly disposed. The young peduncles arise as buds from circular depressions in the rhizome, and do not exhibit any volva or involucre.

The scales on the young capitulum are all ascending and imbricating, and do not assume the peltate and hexagonal form till a subsequent period.

At the base of the capitulum are seen several rows of small conical protuberances that appear to be undeveloped bracts. The annular projection which represents an involucre never to be developed, is situated close under the capitulum for some time after the lengthening of the lower part of the peduncle; finally, however, the upper part of the peduncle elongates most, and the annulus hence occupies a middle position upon it.

The articulated threads of the surface of the capitula are stout, of several collateral cells in breadth, and the upper eight or ten cells are smaller and become sphacelate very soon. In a young state these terminal cells are seen to contain several nuclei, and they are all enclosed in a membrane of excessive delicacy, forming a balloon around them; they appear much whiter than the other cells at this early period, but afterwards are darker and become minutely wrinkled on the surface.

At the earliest period at which the female flowers can be recognized, they appear as minute 2–3-lobed cellular papillæ, broader than long, upon the surface of the capitulum. When 2-lobed, the lobes (which lengthen into styles) are widely separated at their bases and diverge. As they increase, the lobes lengthen and approximate; and if a third one be present, it is the middle one of the three that is suppressed.

At this period the perianth is not distinguishable, but appears after the flowers have assumed their complete form, as a broadly campanulate 2- (sometimes 3–4-?) lobed superior calyx, much larger in proportion to the ovary than at any future period; the styles at the same time have approximated, and appear united at their bases into a conical body surmounting the ovary. The full-grown ovary differs in no important particular from that of the preceding species.

EXPLANATION OF THE PLATES.

Tab. I.

A. *Cynomorium coccineum*, Mich.

Fig. 1. Vertical section of a portion of very young capitulum, showing two bracts and their included masses of flowers;—though the lower limb of each bract immediately covers only the mass of flowers below it, the vascular cord of each bract unites with that of the mass of flowers above it.

Fig. 2. A very undeveloped female flower, showing the vascular cords of the ovary.

Figs. 3, 4 & 5. Hermaphrodite flowers.

Fig. 6. A male flower with a regular 6-leaved perianth.

Fig. 7. A female flower showing at *α*. a mamilla, which may be an undeveloped stamen.

Fig. 8. Portion of a male flower showing an undeveloped ovary *a*, and a wholly inferior perianth.

Fig. 9. Another male flower with undeveloped ovary and wholly superior perianth.

Fig. 10. Vertical section of immature fruit.

Fig. 11. Ripe seed and embryo cut vertically.

Fig. 12. Embryo very highly magnified.

Fig. 13. Apex of style and stigma, showing the two vascular cords and intermediate groove filled with conducting tissue.

All the figures very highly magnified.

B. *Mystropetalon Thomii*, Harv.

Fig. 1. Female flower.

Fig. 2. Apex of style and stigmata.

Fig. 3. Vertical section of unripe fruit.

Fig. 4. Ditto of ripe fruit.

Fig. 5. Transverse section of the same.

Fig. 6. Seed.

Fig. 7. Vertical section of ditto.

Fig. 8. Embryo.

All very highly magnified.

C. *Sarcophyte sanguinea*, Sparrm.

Fig. 1. Male flower.

Fig. 2. Segment of perianth with stamen with undehisced anther.

Fig. 3. Vertical section of the same.

Fig. 4. Transverse section of the anther.

Fig. 5. Vertical section of portion of anther with all the cells burst and pollen discharged.

Fig. 6. Tissues of epithelium and pollen-grains.

All very highly magnified.

Tab. II.

Langsdorffia.

Fig. 1. Portion of plant of *L. rubiginosa* (Weddell), nat. size, from a drawing by Sir R. Schomburgk.

Fig. 2. Female flower.

Fig. 3. The same in a very young state.

Fig. 4. Rudimentary female flowers that occur on the male capitulum.
Fig. 5. Unexpanded male flower with rudimentary female at its base.
Fig. 6. Expanded male flower.
Fig. 7. Transverse section of the rhizome showing the five regularly disposed vascular bundles.
Fig. 8. *a*. Tubular barred vessels that form the woody system; *b*. thick-walled elongated cells that form the liber system.
Fig. 9. Surface of rhizome with hairs.
Fig. 10. Portion of a hair.
Fig. 11. Rudimentary condition of a *Langsdorffia* on a rootlet, cut vertically.
Fig. 12. Portion of a rhizome horizontally sliced, showing the intrusion of the root.
Fig. 13. Swollen portion of a rhizome at the point of junction with a root, showing the rootlets of the latter given off apparently by the rhizome, and partially enclosed in it.
Fig. 14. Transverse section of the same, showing the abbreviated termination of the divisions of the root.
Fig. 15. Apex of a rootlet enclosed within the cellular system of the parasite.
Fig. 16. Vertical section of a portion of a rhizome corroding the bark of a rootlet which it has attacked.
Fig. 17. Another vertical section of a root and rhizome, the former sending vascular prolongations into the latter.
Fig. 18. Another section showing the first contact of a rhizome with a rootlet.
Fig. 19. A portion of a rhizome enveloping the branch of a rootlet.
Fig. 20. Ripe fruit of *L. hypogæa*, Rich.
Fig. 21. Vertical section of the same, showing the pendulous seed.
Fig. 22. Seed removed, showing at *a*. the hilum.
All but figs. 1, 12, 13 & 14, very highly magnified.

Tab. III.

Thonningia sanguinea, Vahl.

Fig. 1. Female branch from Vahl's herbarium.
Fig. 2. Male capitulum from Schumacher's herbarium.
Fig. 3. Vertical section of the same.
Fig. 4. Female capitulum from the same herbarium.
Fig. 5. Vertical section of the same.
Fig. 6. Imperfect male flower from Vahl's specimen: *a*. the bract at its base; *b*. two scales of the perianth.
Fig. 7. Male flower from fig. 2,—the anthers dehisced and partially separated at the apex.
Fig. 8. Transverse section of the synema,—the anther-cells all dehisced.
Fig. 9. Pollen-grains.
Fig. 10. Female flower.
Fig. 11. The same with the free tubular limb of the perianth laid open.
Fig. 12. Another female flower with a more developed perianth.
Fig. 13. Portion of apex of perianth, showing the strong sclerogen-tubes that form its woody system.
Fig. 14. Hair from the peduncle.
Fig. 15. Cellular tissue and vessels of the perianth.
All but figs. 1–5 highly magnified.

Tab. IV.

Balanophora involucrata, Hook. fil.

Fig. 1. Fully-formed individual, consisting of a simple tuberous rhizome, and one branch or peduncle with a hermaphrodite capitulum.
Fig. 2. Vertical section of the same.
Fig. 3. Transverse section of peduncle.
Fig. 4. Ditto of capitulum.
Fig. 5. Cellular tissue of surface of peduncle.
Fig. 6. Transverse, and fig. 7. vertical sections of cellular tissue at the circumference of peduncle, where there is a little deposit of wax.
Fig. 8. Cellular tissue of young peduncle, the cells each with a globule of wax.
Fig. 9. A single cell detached, showing its dotted walls and wax-globule with its nucel.
Fig. 10. Another cell more advanced, with the wax-secreting cell burst and its contents discharged in the cavity of the cell.
Fig. 11. Wax-secreting cells at different stages of growth.
Fig. 12. Cellular tissue of rhizome.
Fig. 13. A single cell from the same.
Fig. 14. Transverse section of portion of peduncle and vascular bundle.
Fig. 15. Vertical section of the same, showing the vascular bundle to consist of simple delicate tubes.
Fig. 16. Cuticle of rhizome with empty bladdery cells that give it a granular appearance.
Fig. 17. Vertical section of a portion of the sheathing upper part of the rhizome.
Fig. 18. Transverse section of ditto.
Fig. 19. Transverse section of the rhizome, showing the symmetrical arrangement of the vascular system.
Fig. 20. Vertical section of the same.
Fig. 21. Transverse, and fig. 22. vertical sections parallel to the radius of a portion of the rhizome, showing the termination of the vascular system.
Fig. 23. Very highly magnified view of longitudinal section of a vascular cord and its surrounding tissues; it consists of barred tubes, *a*, enclosed in a cellular tissue whose cells are filled with viscous fluid, *b*: at *c*, some of the cellular tissue of the rhizome is seen containing wax-deposits.
Fig. 24. Barred vessels from 23 *a*.
Fig. 25. Cells surrounding the same with reticulated walls.
Fig. 26. Imperfectly developed spirally marked tubes from the apices of the vascular bundles of rhizome.
Fig. 27. The same much more highly magnified.
Fig. 28. Another fully formed individual.
All but figs. 1, 2, 3, 4 & 28, very highly magnified.

Tab. V.

Inflorescence of *Balanophora involucrata*, Hook. fil.

Fig. 1. Female flowers intermixed with clavate bracts.
Fig. 2. The same with sessile female flowers and pedicelled bracts.
Figs. 3 & 4. Bracts.
Fig. 5. Two adnate female flowers.
Figs. 6, 7 & 8. Female flowers.
Fig. 9. Ovary with base of style.
Fig. 10. Transverse section of cavity of ovary.
Fig. 11. Vertical section of ovary and ovule.
Fig. 12. Ovule at earliest stage examined, supposed to consist of a simple embryo-sac.

Fig. 13. Vertical section of more advanced ovary.

Fig. 14. Immature seed.

Fig. 15. Apex of style, and pollen-grain ; 15 *a*, cells of apex of style before impregnation.

Fig. 16. Base, & fig. 17. apex of style, with pollen-tube traversing it.

Figs. 18 & 19. Male flowers with 2-lobed perianths.

Figs. 20 & 21. Male flowers with 3-lobed perianths.

Fig. 22. Imperfect male flowers showing their reduction to bracts.

Fig. 23. Vertical section of male flower.

Fig. 24. Pollen-grains.

Fig. 25. *Acarus* found on the capitulum.

All very highly magnified.

Tab. VI.

Balanophora involucrata, Hook. fil.

Fig. 1. A young plant which has already caused the root upon which it grows to enlarge very much.

Fig. 2. Vertical section of the same.

Fig. 3. Very highly magnified view of the root and portion of the *Balanophora*, showing the mode of attachment, displacement of the woody system of the root, and apparent interlacement of the vascular systems of the root and parasite: *a.* indicates the bundles of the peduncle, *b.* of the rhizome.

Fig. 4. Very highly magnified slice of the root and parasite at the point of attachment of the latter.

Fig. 5. Transverse section of the root from near the swollen portion, showing the separation of the bark and wood.

Fig. 6. Woody system of the root.

Fig. 7. Vertical section of an exceedingly young *Balanophora*, nidulating in the cellular bark of a root: *a.* spongioles; *b.* position of the nascent vascular bundle in its axis.

Fig. 8. Vertical section of a more advanced, but still very young *Balanophora*, which has apparently germinated on one of the large tubers that this species eventually forms on the roots of maples, &c., and which tuber consists of a confused mass of the tissues of the parasite and root: *a.* spongioles; *b.* nascent vascular bundles in its axis; *c.* root traversing the mass; *d.* cellular tissue of parasite.

Fig. 9. Vessels and cells of the vascular bundle taken from fig. 8 *b*.

Fig. 10. Section at point of union of root, *a*, and parasite, *b*.

Fig. 11. Vascular tissue of the wood of the root taken from fig. 8*c*.

Fig. 12. Very young vascular tissue from the axis of fig. 7.

All but figs. 1 & 2 very highly magnified.

Tab. VII.

A. Male plants of *Balanophora involucrata*, var. *gracilis*, growing on the roots of an Oak. 1. male, and 2. female plant.

B. Male and female plants of *B. involucrata*, var. *Cathcartii*.

Fig. 1. Male flower magnified.

Tab. VIII.

Balanophora fungosa, Forst., from N.E. Australia.

Fig. 1. Plant of the natural size, but the flowers not fully developed.

Fig. 2. Male flower.

Fig. 3. Synema.

Fig. 4. The same with the anthers dehisced.

Fig. 5. Transverse section of column of synema, showing four vascular bundles and anther-cells.

Fig. 6. Pollen-grains.

Fig. 7. Female flowers on the pedicel of the bract.

Fig. 8. Female flower.

Fig. 9. Apex of style.

Fig. 10. Transverse section of rhizome from near the root, showing that the arrangement of the woody systems of the vascular branches that radiate outwards from the root in the mass of the rhizome is the same as that of the root, but dislocated.

Fig. 11. The same from a point further removed from the root, showing a further dislocation of the woody system.

Fig. 12. Very highly magnified vertical section of vascular bundle of rhizome, showing *a.* the cellular tissue of the *Balanophora*; *b.* the cellular tissue surrounding the woody system; *c.* the woody system.

Fig. 13. Cellular tissue of circumference and cuticle of the rhizome.

Fig. 14. Cellular and vascular tissue of the termination of the bundles.

Fig. 15. Transverse section of root of the stock.

Fig. 16. Woody tissue of the root of the stock.

All highly magnified.

Tab. IX.

Lophophytum Weddellii, Hook. fil.

Fig. 1. Portion of section of male inflorescence.

Fig. 2. Ditto of female.

Both magnified.

Tab. X.

Sphærorhizon depressum, Hook. fil.

Figs. 1–4. Individuals at various stages of growth.

Fig. 5. Very young male flower.

Fig. 6. Mature bud of male flower with articulate filaments.

Fig. 7. The same with the perianth partly removed.

Fig. 8. Transverse section of anther-cells.

Fig. 9. Ditto of one anther-cell.

Fig. 10. Tissue of anther-cells.

Fig. 11. Pollen-grains.

Fig. 12. Very young female flower and articulated filament.

Fig. 13. Mature female flower.

Fig. 14. Vertical section of ditto.

Figs. 15 & 16. Articulated filaments.

All but 1–4 very highly magnified.

Tab. XI.

Phyllocoryne Jamaicensis, Hook. fil.

Figs. 1, 2. Male individuals in different stages of growth.

Figs. 3, 4. Female individuals.

Fig. 5. Articulated filaments; 5 *a.* apex of ditto.

Fig. 6. Male flower.

Fig. 7. Male flower with portion of perianth removed.
Fig. 8. Synema with anthers burst at their apices.
Fig. 9. Transverse section of anthers.
Fig. 10. Pollen-grains.
Fig. 11. Female flower.
Fig. 12. Longitudinal section of ditto.
Fig. 13. Apex of style and stigma.
Fig. 14. Transverse section of style.
Fig. 15. Fruit, *in situ*.
Fig. 16. The same removed.
Fig. 17. Vertical section of ditto.
Fig. 18. Seed.
Fig. 19. Grains of albumen.
Fig. 20. Rudimentary flowers at base of male capitulum.
Fig. 21. One of the same detached.
Fig. 22. Another of the same, more developed.
All but figs. 1–4 very highly magnified.

Tab. XII.

Rhopalocnemis phalloides, Jungh.

Fig. 1. Male plant.
Fig. 2. Female ditto.
Fig. 3. Male flower and articulated filaments.
Fig. 4. Transverse section of anthers.
Fig. 5. Female flower and articulated filaments.
All but figs. 1 & 2 highly magnified.

Tab. XIII.

Corynæa crassa, Hook. fil.

Fig. 1. Plant of the natural size.
Fig. 2. Very young plants attached to the branches of a root.
Fig. 3. Bud of male flower.
Fig. 4. Expanded male flower.
Fig. 5. The same far advanced, the pedicel of the synema having lengthened greatly.
Fig. 6. Transverse section of anthers.
Fig. 7. Pollen-grains.
Fig. 8. Very young female flowers, showing the ovary to be 2-lobed at that age.
Fig. 9. Articulated filament and female flower before the falling away of the bracts, showing the position of the styles.
Fig. 10. Mature female flower.
Fig. 11. Vertical section of nearly ripe fruit exposing the seed and embryo*.
Fig. 12. Section of ripe seed and embryo.
Fig. 13. Embryo removed from the seed.
Fig. 14. Apex of style and stigma.
Fig. 15. Transverse section of style.
Fig. 16. Young articulated filament, its cells still nucleated.

* See foot-note at p. 54.

Fig. 17. Cells from fig. 16, showing the cell-contents.
Fig. 18. Fully formed articulated filaments after the fall of the scales of the capitulum.
Fig. 19. The same, showing the appearance of the terminal cells.
Fig. 20. Old terminal cells of the articulated filaments, showing their wrinkled walls.
All but figs. 1 & 2 very highly magnified.

Tab. XIV.

Corynæa sphærica, Hook. fil.

Fig. 1. Mature, and fig. 2. Immature plants.
Fig. 3. Vertical section of fig. 2.
Fig. 4. Peltate bract.
Fig. 5. Immature male flower and articulated filaments.
Fig. 6. Ditto more advanced.
Fig. 7. Ditto expanded.
Fig. 8. Transverse section of anthers.
Fig. 9. Articulated filaments.
Figs. 10 & 11. Mature female flowers.
Fig. 12. Vertical section of fruit.
Fig. 13. Seed.
Fig. 14. Section of portion of rhizome showing the two portions of the root to be completely severed in the axis of the rhizome.
All but figs. 1, 2 & 3, highly magnified.

Tab. XV.

Helosis Mexicana, Liebm.

Fig. 1. Plant of the natural size.
Fig. 2. Vertical section of capitulum and upper part of peduncle.
Fig. 3. Very young peduncle on a branch of the rhizome.
Fig. 4. Vertical section of the same magnified.
Fig. 5. Portion of capitulum vertically cut, showing the imbrication of the very young bracts.
Fig. 6. Fully developed bract.
Fig. 7. Vertical section of ditto.
Fig. 8. Nascent *Helosis* on a rootlet.
Fig. 9. Vertical section of a very young *Helosis* which has fully established itself on a root.
Fig. 10. Vertical section of a full-grown tuber of the rhizome, showing its attachment to the root.
Fig. 11. Similar section of another and larger one.
Fig. 12. Transverse section of the peduncle, showing eight regularly placed vascular radiating bundles.
Fig. 13. Vascular tissue of the same.
Fig. 14. Transverse section of the rhizome, showing—*a.* lobed medullary sheath surrounding the axis or pith; *b.* wedges of vascular tissue; *c.* liber; *d.* detached masses of sclerogen-cells.
Fig. 15. Cells of liber.
All but figs. 1, 2, 3, 8 & 10, very highly magnified.

Tab. XVI.

Helosis Mexicana, Liebm.

Fig. 1. Bud of male flower.
Fig. 2. More advanced male flower.
Fig. 3. Fully formed male flower with the lobes of the perianth spreading.
Fig. 4. Young synema.
Fig. 5. Fully formed synema.
Fig. 6. Pollen-grains. These are probably incorrectly represented; the appearance of pollen-tubes may be due to the presence of the mycelium of a fungus: these and the pollen-grains were black.
Fig. 7. Tube of the male perianth laid open, showing the conical rudiment of an ovarium at its base.
Figs. 8, 9 & 10. Very young state of female flowers with articulated filaments, showing the compound nature of the ovarium.
Fig. 11. Fully formed but immature female flower, with the limb of the perianth laid open.
Fig. 12. Another female flower of a different form.
Fig. 13. Vertical section of young female flower showing the albumen of the seed to be already formed, apparently before fecundation has taken place.
Fig. 14. Mature female flower.
Fig. 15. Vertical section of the same, showing the pendulous ovule.
Fig. 16. Apex of style and stigma.
Fig. 17. Vertical section of nearly ripe fruit.
Fig. 18. Transverse section of ditto with the seed removed.
Fig. 19. Seed.
Fig. 20. Transverse section of ditto.
Figs. 21 & 22. Articulated filaments, showing the bladdery membrane enclosing the uppermost cells.
Fig. 23. Apex of the same more highly magnified.
Fig. 24. Apex of another articulated filament.
Fig. 25. Transverse section of portion of rhizome: *a.* vascular axis; *b.* medullary sheath; *c.* vascular wedge; *d.* liber; *e.* sclerogen-cells.
Fig. 26. Vertical sections of tissues forming the vascular system from the axis to the circumference: *a.* pleurenchyma that occupies the axis; *b.* medullary sheath; *c.* vascular wedge of wood formed of angular thin-walled vessels; *d.* liber-cells; *e.* cellular tissue.
Fig. 27. More highly magnified vessels of axis or pith.
Fig. 28. Ditto of wood.
Fig. 29. Transverse section of vascular system;—the letters refer to the same tissues as in fig. 26.
Fig. 30. Section of stem of *Helosis Guyanensis* from Brazil (Mr. Miers), showing the supplementary liber-bundles alternating with those first formed.

All very highly magnified.